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# TYPE MORENO FORMATION

## AND OVERLYING EOCENE STRATA ON THE WEST SIDE OF THE SAN JOAQUIN VALLEY, FRESNO AND MERCED COUNTIES, CALIFORNIA

By MAX B. PAYNE

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# TYPE MORENO FORMATION AND OVERLYING EOCENE STRATA ON THE WEST SIDE OF THE SAN JOAQUIN VALLEY, FRESNO AND MERCED COUNTIES, CALIFORNIA *

By Max B. Payne **

## OUTLINE OF REPORT


| | Page |
|---|---|
| Abstract | 3 |
| Introduction | 3 |
| Acknowledgments | 5 |
| Previous work | 5 |
| General geology | 5 |
| Panoche formation | 7 |
| Moreno formation | 7 |
| Laguna Seca formation | 11 |
| Lodo formation | 13 |
| Domengine formation | 15 |
| Chaney Ranch sandstone | 15 |
| Kreyenhagen shale | 18 |
| Temblor formation | 18 |
| Bibliographic references | 19 |
| Index of geographic names | 20 |
| Appendix A, measured sections | 20 |
| Section 1, Kreyenhagen shale formation in Chaney Ranch Canyon | 20 |
| Section 2, Chaney Ranch sandstone | 20 |
| Section 3, Capita shale in Chaney Ranch Canyon | 21 |
| Section 4, Nonada sandstone member of the Domengine formation in Capita Canyon | 21 |
| Section 5, Lodo shale formation in Escarpado Canyon | 21 |
| Section 6, Upper Dos Palos shale member of the Moreno formation | 22 |
| Section 7, Cima sandstone lentil of the Dos Palos shale member of the Moreno formation | 22 |
| Section 8, Gres Canyon, Panoche Hills | 22 |
| Section 9, Mercy sandstone lentil of the Moreno shale formation | 24 |
| Section 10, Laguna Seca sandstone formation at the type section | 24 |
| Appendix B, Fossil registers | 25 |
| Microfossil register | 25 |
| Megafossil register | 27 |
| Vertebrate register | 28 |
| Fossil localities | 29 |


### Illustrations


| | | Page |
|---|---|---|
| Figure 1. | Index map of the State of California | 4 |
| 2. | Geologic map of the Moreno and Eocene in Laguna Seca Hills | 6 |
| 3. | View north to top of Panoche from the head of Escarpado Canyon | 7 |
| 4. | Geologic map of the Moreno and Eocene in northern Panoche Hills | 8 |
| 5. | Southeast Panoche Hills | 10 |
| 6. | Geologic map of the Moreno and Eocene in SE Panoche Hills | 12 |
| 7. | View east down Escarpado Canyon | 14 |
| 8. | View N. 50° W. to the Cima sandstone in Escarpado Canyon | 14 |
| 9. | Gres Canyon section | 16 |
| 10. | View NW across the mouth of Garzas Creek | 17 |
| 11. | View east down Laguna Seca Creek | 17 |
| Plate 1. | Geologic map of the type Moreno formation and overlying Eocene strata | In pocket |
| 2. | Comparative lithologic columnar sections | In pocket |
| 3. | Comparative columnar sections showing nomenclature | In pocket |
| 4. | Columnar sections of the Eocene and uppermost Cretaceous sediments in the Panoche and Laguna Seca Hills | In pocket |
| 5. | Lithologic columnar sections of wells | In pocket |


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** Geologist, Signal Oil and Gas Company, Bakersfield, California.

## ABSTRACT

The purpose of the present study is to record the detailed stratigraphy and paleontology of the members of the Moreno formation and adjacent Eocene formations. Fossil localities are registered and shown on the geologic maps and, where known, stratigraphic ranges for the fossils are given. Escarpado Canyon in the Panoche Hills is chosen as the type section for the members of the Moreno formation, which is divided from the bottom upward into four members: the Dosados sand and shale; the Tierra Loma shale, including the Mercy sand lentil; the Marca shale; and the Dos Palos shale, including the Cima sand lentil. Regional geology is illustrated on a small scale map with three large scale maps for greater detail of small critical areas. The Moreno formation and overlying Eocene formations are mapped in detail from Ciervo Mountain anticline on the south to Garzas Creek on the north, a distance of some 60 miles.

The Eocene is divided into five formations: the Lodo, the Laguna Seca (new formation name), the Domengine, the Chaney Ranch, the Kreyenhagen shale. The Domengine is divided into two members (new names): the Capita shale (upper) and the Nonada sand (lower). The Chaney Ranch formation (new name), lying above the Domengine and below the Kreyenhagen formation, is recognized. Stratigraphic sections of the Eocene formations are measured and described to clarify the relationship of the Eocene to the underlying Cretaceous formations. From the type section in the Panoche Hills northward to Garzas Creek the Moreno formation is mapped much higher than previously reported with no Moreno remaining in outcrop north of Los Banos Creek. The Eocene transgresses the Cretaceous progressively in a northerly direction from Escarpado Canyon, cutting out more and more of the subjacent Cretaceous. Fossil lists from the sands immediately below the Eocene sand occurring in outcrop from Los Banos Creek to Garzas Creek include such Panoche forms as *Lytoceras*, "*Parapachydiscus*," *Inoceramus, Cymbophora ashburneri, Turritella chicoensis*, a Dinosaur and a Mososaur. The white Eocene sand at Garzas Creek lies on a Cretaceaus (Panoche) sand containing the *Turritella chaneyi* fauna with *Turritella chaneyi, Inoceramus, Cymbophora n. sp., Cophocara stantona* Stewart, *Diplomoceras sp.*, and *Baculites sp.*, and this uppermost Cretaceous sand in Garzas Creek is underlain by brown Cretaceous shale containing the *Siphogenerinoides clarki* fauna which is found only below the top of the Panoche formation in the type section. The writer believes the Cretaceous in the Garzas Creek section is lower than the type Moreno basing this on the tracing of beds lower than Moreno from the type section into the top of the Garzas Creek section, and faunally the top of the Garzas Creek Cretaceous is equivalent to some part of the upper Panoche formation.

## INTRODUCTION

The type Moreno formation was named by Anderson and Pack in 1915, but it has received relatively little attention until the last few years. This study was begun in 1936, but much of the work was carried on between 1938 and 1941 while the writer was in the employ of the Richfield Oil Corporation.

The paper is concerned chiefly with the several members of the Moreno (Upper Cretaceous) formation and overlying Eocene strata which occur in the Panoche Hills on the west side of the San Joaquin Valley, Fresno and Merced Counties, California. The area contains a great thickness of well exposed fossiliferous, marine strata of uppermost Cretaceous and Eocene age, and it is felt that the most continous and complete section may be found here. This homoclinal section consists of more than 21,000 feet of Cretaceous sands and shales and as much as 3000 feet of Tertiary strata.

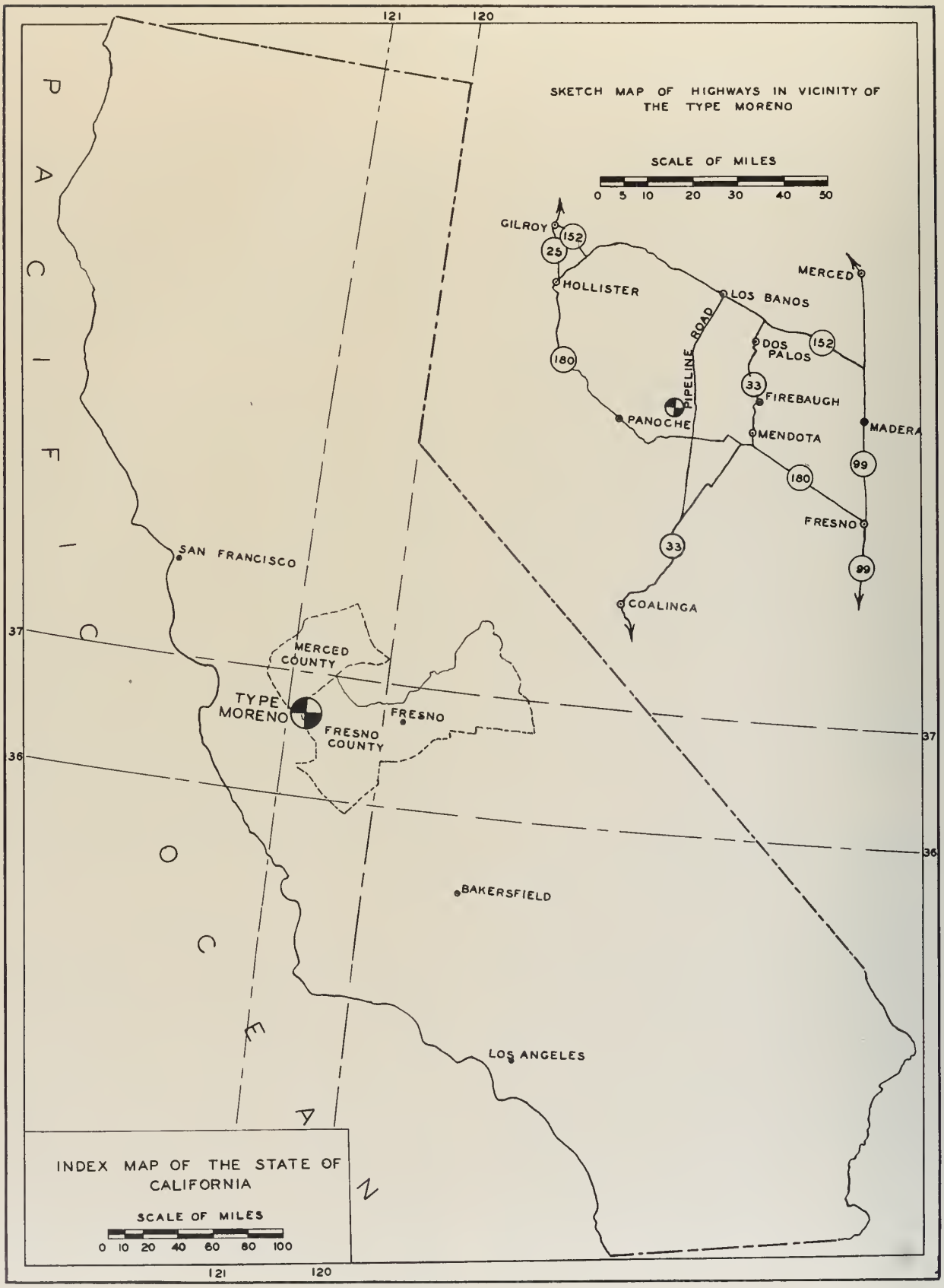


FIGURE 1. Index map of the State of California.

This paper is intended to be strictly stratigraphic, to show lithologic and lithogenetic units as mapped in the field, to present detailed measured and described sections of these units, and to give their relationship one to the other. Where new units occur in the section they have been described and delimited. Precise allocations are given for faunules in relation to these cartographic units as documentary evidence for time-stratigraphic determinations. Fossils are registered and their stratigraphic ranges given. Fossil localities are shown on the map only where space allows but all localities are given in the fossil registers as exactly as the scale of the base map permits. It is hoped that further work will eventually establish the exact relationship between the Cretaceous, the Paleocene, and the Eocene of California.

## ACKNOWLEDGMENTS

The writer is especially indebted to Hubert G. Schenck, Stanford University, who suggested this study in 1936 and who has been a constant source of inspiration and supervision in following it to completion. The frequent advice of Mason L. Hill, Richfield Oil Corporation, has been of great help in the completion of this paper. Lois T. Martin, Stanford University, and Stanley Carlson, Richfield Oil Corporation, have given important foraminiferal data. V. T. Allen, Saint Louis University, and Konrad Krauskopf, Stanford University, have supplied mineralogical data. Myra Keen, Stanford University, has identified and assumed care of fossils and helped in numerous ways. Siemon W. Muller, Stanford University, visited the writer in the field, and collected and identified fossils. Herdis Bentson, University of California, gave access to type fossil collections for comparisons. Robert T. White, Barnsdall Oil Company, has lent encouragement and advice and has helped in editing the paper. Rollin Eckis, Richfield Oil Corporation; Lesh Forrest, General Petroleum Corporation; and Glen W. Ledingham, Western Gulf Oil Company, have edited and criticized the final draft. Robert M. Kleinpell, University of California, Berkeley, has given constant encouragement and advice. To Harold W. Hoots and Rollin Eckis, and to many others, the writer offers his sincere thanks and appreciation.

## PREVIOUS WORK

Anderson and Pack [1] published the first and to date the only geologic map of this general region. They reviewed earlier work, designated type localities for the Moreno and Panoche formations, and divided the Eocene system into the Kreyenhagen, Tejon, and Martinez (?) formations. However, their work received little attention until the last few years. Since then additional work has been done largely by oil companies.

An abstract of this paper was given before the Geological Society of America at Leland Stanford Junior University, in April, 1941. At that time the Moreno was subdivided into its several members; the upper brown Dos Palos shale and the Cima sand lentil were placed as probable Paleocene in age, and the top of the Panoche formation north of the Panoche Hills was placed much higher than it had previously been designated by other workers.

[1] Anderson, Robert, and Pack, R. W., Geology and oil resources of the west border of the San Joaquin Valley north of Coalinga, California: U. S. Geol. Survey Bull. 603, 1915.

## GENERAL GEOLOGY

The formations of the area between Panoche Creek and Garzas Creek comprise an eastward-dipping homocline of Upper Cretaceous and Eocene marine sediments. For the most part, the section is well exposed and uncomplicated structurally and is readily accessible. Although more than 21,000 feet of Cretaceous sandstone and shale crop out in the area, this paper is confined to a discussion of the upper part of the Cretaceous section and the superjacent Eocene formations. Vertebrates, mollusks, plants, and foraminifers have been found in the Cretaceous rocks. The Eocene contains mollusks and foraminifers and the Miocene has a molluscan fauna. The general uniformity in lithologic character and thickness of the members of the Moreno is another aid in defining the several cartographic units. Eocene sedimentary rocks crop out in two areas separated by the overlapping Temblor formation. This overlap can be seen where it is conspicuous on the map near the T. 14 S.-T. 15 S. line. From Panoche Creek north to Wedge Canyon the Temblor strikes more and more westerly until it is hidden beneath the terrace deposits that overlap the whole section as far down as the lower part of the Moreno formation. This Miocene overlap and terrace-covered area leaves a gap between the north and south part of the Panoche Hills, and north and south of this overlap the sequence of Eocene strata is dissimilar.

In the southern part of the area, three formations transgress the underlying beds in a short distance south of the T. 14 S.-T. 15 S. line. They are: 1) the Temblor formation which lies progressively on older beds until it is in contact with the Moreno near the center of N½ sec. 6, T. 15 S., R. 12 E.; 2) the Domengine pebble bed which completely overlaps the Lodo formation in the southwest corner of sec. 5, T. 15 S., R. 12 E., about 3 miles north of Panoche Creek; and 3) the Lodo formation which, though apparently accordant, is considered to be disconformable with the Moreno formation since the brown shale immediately below it is progressively thinner northward from Panoche Creek to Wedge Canyon and is completely overlapped at a point 1350 feet north of the southwest corner of sec. 5, T. 15 S., R. 12 E. As additional evidence of disconformity, attention is called to the fact that the base of the Lodo transgresses the upper members of the Moreno formation from Panoche Creek southward to Cerros Hill, at the W¼ sec. 14, T. 16 S., R. 12 E., M. D. M. Here the base of the Cerros shale member (lowest member of the Lodo formation) lies only 90 feet above the top of the Marca shale member of the Moreno, or 770 feet stratigraphically lower in the section than it does in Escarpado Canyon. Farther south along Tumey Gulch the Dos Palos brown shale member, above the Marca shale member, again approaches the thickness of this same member in the Panoche Hills.

The sequence of the Eocene sediments found in outcrop north of the Temblor overlap differs considerably from the Eocene sequence in the southern part of the area. The Laguna Seca sandstone formation lies on the Cima sandstone of the Moreno formation north of the T. 14 S.-T. 15 S. line. Farther north, in Laguna Seca Creek, the Laguna Seca sandstone formation is 1120 feet thick and has transgressed the Moreno shale down to the lower part of the white-weathering Marca shale member. A general study of the map shows the uniformity in thickness

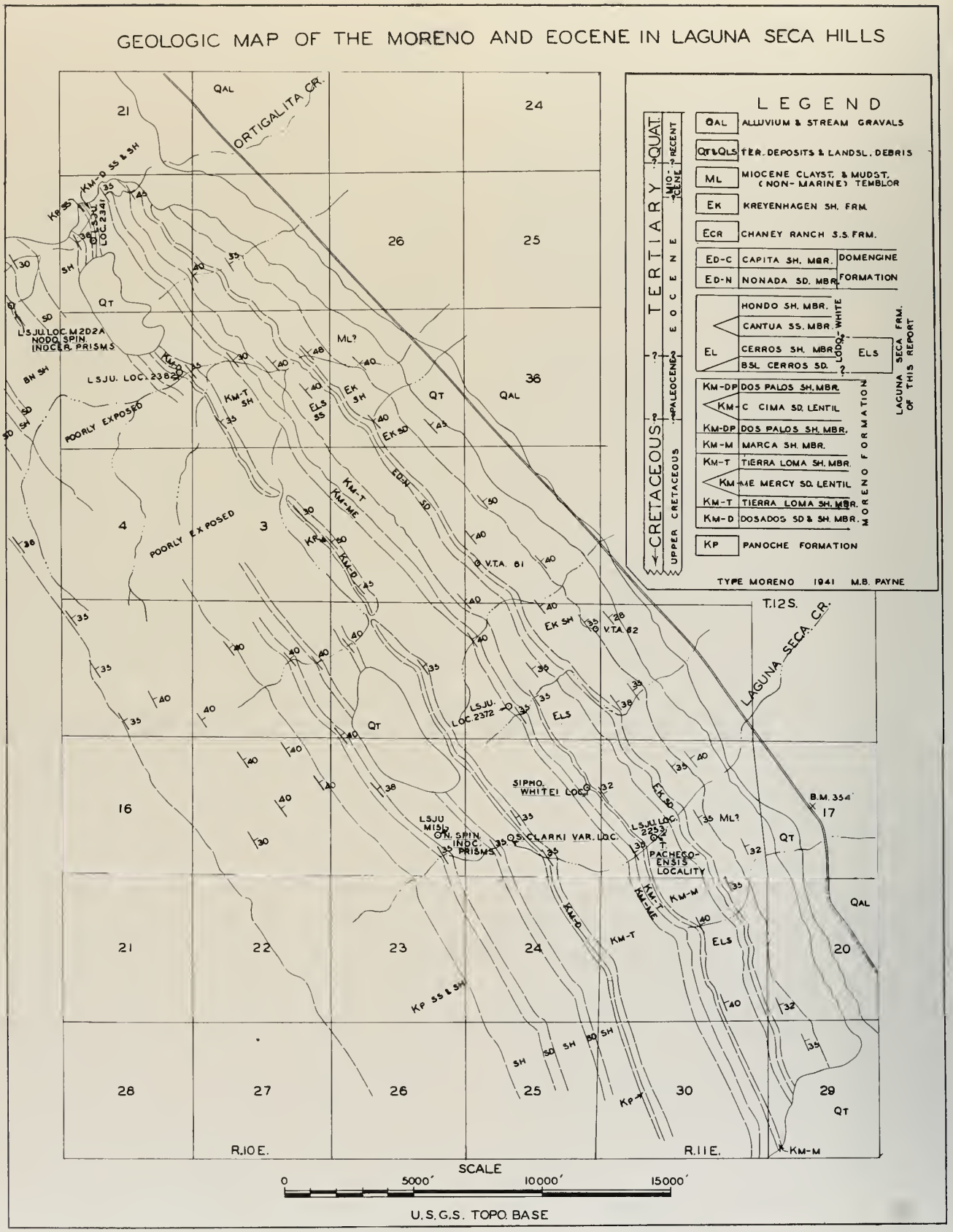


FIGURE 2. Geologic map of the Moreno and Eocene in Laguna Seca Hills.

of the members of the Moreno in the Panoche Hills. The lower contact of the Moreno is marked by the thin but continuous concretionary sandstone unit of the Panoche formation. The white-weathering Marca shale member divides the brown Moreno shale into upper and lower shale units. Delimiting the Marca shale is a definite aid in mapping and is especially useful in the Ciervo Hills where structure is involved.

As opposed to the uniformity of the Moreno formation in the Panoche Hills, the Eocene is variable. Just north of Panoche Creek, the Eocene formations become thinner due to two unconformities. In the same area the basal Eocene strata cut out the thin upper units of the Moreno by overlap both north and south of Panoche Creek. On the geologic map the two lenticular sands of the Moreno pinch out in opposite directions in the same vicinity in secs. 4 and 9, T. 16 S., R. 12 E.

## PANOCHE FORMATION

The two following paragraphs are abstracts from Anderson and Pack's [2] more detailed description of the Panoche formation.

The original definition of the Panoche formation by Anderson and Pack designated Moreno Gulch as the type locality. It stated that the Panoche formation comprises the Upper Cretaceous strata lying below the maroon and associated beds of the Moreno formation. The Panoche embraces beds of diverse lithology, varying from clay shale to conglomerate beds composed of boulders up to several feet in diameter; its aggregate thickness is at least 20,000 feet. The line of separation between the Panoche and the overlying Moreno is not sharp, the lower sandy beds apparently grading upward into the shaly beds through a thickness of interbedded shale and sandstone. It is probable that no break in sedimentation exists between the Panoche and Moreno formations; the line of separation is arbitrary.

In Panoche Hills the thick Panoche formation may be separated roughly into three lithologic divisions: 1) The upper division, immediately underlying the Moreno formation, is composed mainly of massive concretionary sandstone with a minor amount of dark shale, aggregating not less than 4000 feet in thickness. The beds form the rugged topography characteristic of the eastern half of the Panoche Hills. 2) Underlying this is 17,000 feet of alternating shale and concretionary sandstone with a persistent member of interbedded coarse conglomerate and fine sandstone 100 to 500 feet thick at the base. This basal member contains "Chico" fossils, some of which appear to be in pebbles of sandstone. 3) Below the heavy conglomerate is the third division, consisting of thin-bedded carbonaceous sandstone and shale lithologically similar to those overlying the conglomerate.

In this present paper the top of the Panoche formation is taken at the same concretionary sandstone designated by Anderson and Pack, and contains the following fossils at L. S. J. U. Locality 2251, identified by Hubert G. Schenck, Myra Keen, and R. A. C. Brown: *Turritella chicoensis, Acila (Truncacila) demessa, Parallelodon (Nanonavis)* cf. *vancouverensis, Baculites* cf. *fairbanksi,* and *Hamites ellipticus.*

## MORENO FORMATION

*Type Locality.* Anderson and Pack [3] named Moreno Gulch the type locality for the Moreno formation. This gulch is 8 miles north of Panoche Creek and is in secs. 1

[2] Op. cit.

[3] Op. cit.

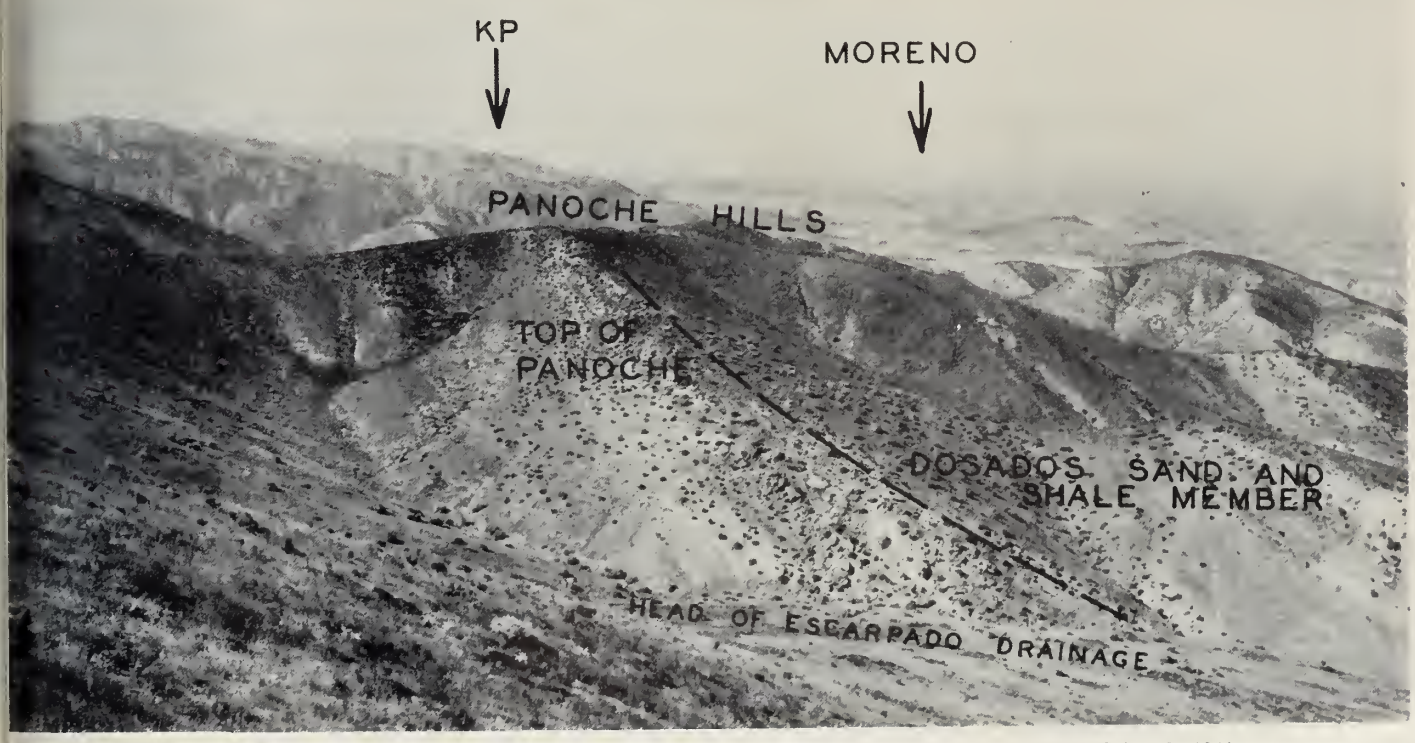


FIGURE 3. View north to top of Panoche from the head of Escarpado Canyon. Photo by H. G. Schenck, 1941.

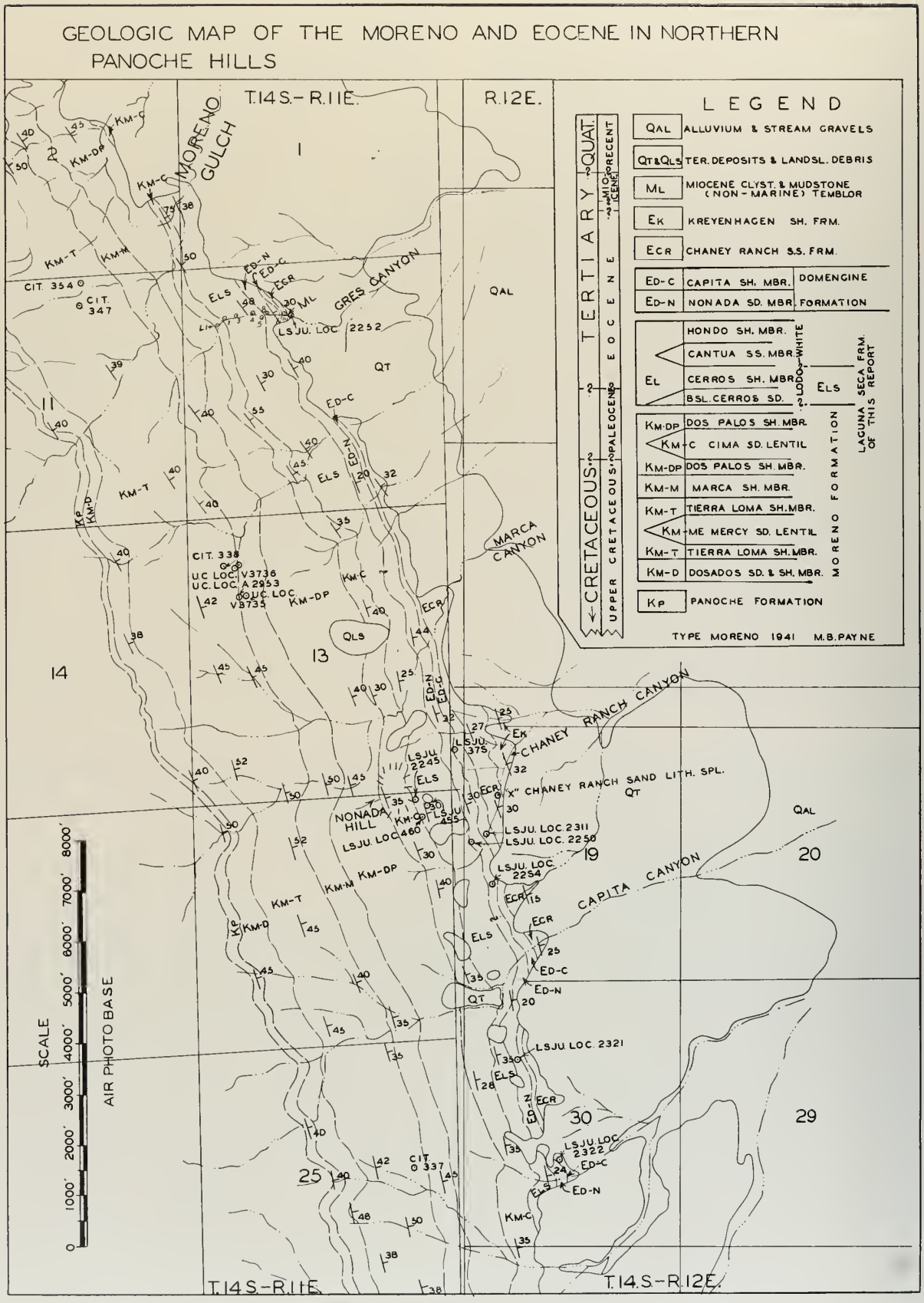


FIGURE 4. Geologic map of the Moreno and Eocene in northern Panoche Hills.

*Members of the Moreno formation in type section.*

| Member | Derivation of name | Type locality | Lower contact | Upper contact | Dominant lithology | Thickness at type locality | Fossils |
|---|---|---|---|---|---|---|---|
| Dos Palos shale | Town of Dos Palos | Escarpado Canyon, sec. 7, 8, T. 15 S., R. 12 E., M.D.M. | 2100 ft. S., 3200 ft. E. of NW corner sec. 7, T. 15 S., R. 12 E. | 2800 ft. S., 1300 ft. E. of NW corner sec. 8, T. 15 S., R. 12 E. | Brown shale. | 900 ft. including 80 ft. of Cima sand lentil. | Megafossils |
| Cima sand lentil within the Dos Palos shale | Spanish word for peak given to hill 1800 ft. S., 50 ft. W of NE corner sec. 7, T. 15 S., R. 12 E. | Escarpado Canyon, sec. 7, 8, T. 15 S., R. 12 E. | 2700 ft. S., 600 ft. E. of NW corner sec. 8, T. 15 S., R. 12 E. | 2800 ft. S., 800 ft. E. of NW corner sec. 8, T. 15 S., R. 12 E. | Gray sand, fine-grained, silty, micaceous, massive, friable, and concretionary. | 80 ft. | Rare Molluscan remains |
| Marca shale | Canyon with mouth at center of sec. 13, T. 14 S., R. 12 E., drains through same section. | Escarpado Canyon, sec. 7, 8, T. 15 S., R. 12 E. | White concretions and white weathering shale 1600 ft. W., 1800 ft. S. of NE corner sec. 7, T. 15 S., R. 12 E. | White concretions and white weathering shale 2100 ft. S., 1200 ft. W. of NE corner sec. 7, T. 15 S., R. 12 E. | Varies from soft and punky to firm or very hard, white to light brown color. Hard calcareous concretions at top and bottom. | 300 ft. | Vertebrates at base Megafossils Foraminifera |
| Tierra Loma shale | Tierra Loma Schoolhouse on Tierra Loma quadrangle near E¼ corner sec. 9, T. 14 S., R. 12 E. | Escarpado Canyon, sec. 7, 8, T. 15 S., R. 12 E. | At first sand of interbedded sand and shale | At contact of white concretions and white weathering shale. | Brown shale with local sandstone dikes. | 1150 ft. | Vertebrates Megafossils Foraminifera |
| Mercy sand lentil | Mercy Bros., Mercy Hot Springs | Mercy Canyon, sec. 15, T. 16 S., R. 12 E. | 2200 ft. N., 1200 ft. W. of SE corner sec. 9, T. 16 S., R. 12 E. | 2250 ft. S., 600 ft. W. of NE corner sec. 9, T. 16 S., R. 12 E. | Fine-grained, micaceous, massive, platy, concretionary with brown shale interbeds. | 180 ft. | Arenaceous Foraminifera |
| Dosados sand and shale | Contraction of Spanish dos a dos | Escarpado Canyon | 400 ft. S., 600 ft. W. of NW corner sec. 12. | 700 ft. S., 75 ft. E. of NW corner sec. 7. | Sands and shales, irregularly bedded, local dikes. | 200 ft. | Vertebrates Foraminifera Megafossils |

and 11, T. 14 S., R. 11 E. The base of the Moreno at the type locality is 1700 feet north and 2100 feet west of the southeast corner of sec. 11, T. 14 S., R. 11 E. The upper contact as designated by Anderson and Pack is exposed at a point 50 feet north and 100 feet west of the southeast corner of sec. 2, T. 14 S., R. 11 E., but in this report is placed as 1200 feet north on the west section line from the southwest corner of sec. 1, T. 14 S., R. 11 E.

The type locality of the members of the Moreno formation is designated herein as Escarpado Canyon. This canyon is 6 miles south of Moreno Gulch and 2 miles north of Panoche Creek. The mouth of this eastward-draining canyon is near the center of the $S\frac{1}{2}NW\frac{1}{4}$ sec. 9, T. 15 S., R. 12 E. Escarpado Canyon is the type section for all the members of the Moreno except for the Mercy sandstone lentil of the Tierra Loma shale member. The type locality for this unit is designated as Mercy Canyon, sec. 15, T. 16 S., R. 12 E.

*Original Definition by Anderson and Pack.*[4] Anderson and Pack described the Moreno formation in great detail as follows:

"The name Moreno is applied to the formation from Moreno Gulch, on the east flank of the Panoche Hills, where it is typically exposed. Here the formation has a thickness of 1,700 to 2,000 feet and is composed predominantly of thin-bedded, rather brittle brownish and lavender-colored shales, that weather into small bits and flakes. In the lower part of the formation there are numerous beds of sandstone, locally containing poorly developed concretions and in general similar to the sandstone of the Panoche formation. The upper half of the formation is more nearly pure shale and contains a greater proportion of material of organic origin. Calcareous shale, limestone nodules, and layers of semiporcelaneous siliceous shale occur locally, and near the top of the formation there is a zone of white platy diatomaceous shale about 200 feet thick. This zone is traceable most of the way along the face of the Panoche Hills. Large sandstone dikes traversing the shale are very conspicuous, a zone of several such dikes being traceable for most of the distance across the strike of the formation. Calcareous concretions are scattered through the shale, especially in the middle of the formation, but are not so numerous as they are in this formation in some other localities. Besides the foraminifers, fossil mollusks occur sparingly, among them being *Hamites* or *Anisoceras*, characteristic Cretaceous forms.

The line of separation between the Moreno and the underlying Panoche formation is somewhat arbitrarily drawn at the horizon where the sandstone beds that form the steep eastern face of the Panoche Hills dip beneath the predominantly shaly beds. The upper limit of the Moreno formation is marked by the overlying Eocene formation, which is composed of medium to fine grained grayish-white sandstone stained in irregular bands by iron oxide and weathering to a tawny-yellow color" . . .

* * * * *

"Its [the Moreno] relation to the overlying Martinez (?) formation resembles a conformity just as much as the apparent gradation into the Panoche below, so far as the usual appearance of the contact goes. The paleontological evidence, however, favors the supposition of a conformity below and an unconformity at the top."

The lower contact of the Moreno formation, as here used, is stratigraphically the same as that chosen by Anderson and Pack. The massive concretions of the upper ridge-forming Panoche sandstone make it distinct from the flaggy sandstone of the type lower Moreno. The upper sandstone of the Panoche is the most uniform and continuous sandstone in this part of the section along the Panoche Hills. Although the overlying sandstones of the lower Moreno are in places massive and concretionary, by contrast with the Panoche, they are lenticular, irregularly bedded, and separated into relatively thin beds by interbedded brown shales. The location of the top of the Panoche sandstone in Moreno Gulch is 1700 feet north

[4] Op. cit., pp. 46-47.

FIGURE 5. Southeast Panoche Hills, immediately north of Panoche Creek showing the type section of the members of the Moreno formation in Escarpado Canyon. Note the terrace covered area right at the T. 14 S., T. 15 S., line which covers the whole section down to the Dosados member. The Eocene found in the section to the north and south of

and 2100 feet west of the southeast corner of sec. 11, T. 14 S., R. 11 E., and in Escarpado Canyon is 400 feet south and 700 feet west of the northeast corner of Sec 12, T. 15 S., R. 11 E.

The upper contact of the Moreno formation, as here defined, is not the same as that of Anderson and Pack. The sandstone at the top of the brown shale (lower Dos Palos) in Moreno Gulch is considered to be equivalent to the Cima sandstone of Escarpado Canyon, 6 miles south.[5]

| | Sample 1 Four megascopic types of rock with 3 suitable for heavy mineral analysis | | | Sample 2 |
|---|---|---|---|---|
| | Chaney Ranch 1 | Chaney Ranch 3 | Chaney Ranch 4 | Escarpado Canyon "C" |
| Ilmenite | A | A | A | A |
| Limonite et al. | A | A | A | A |
| Zircon | A | C | C | A |
| Biotite et al. | -- | C | R | C |
| Hornblende | C | -- | VR | -- |
| Clinozoisite | -- | -- | -- | C |
| Tourmaline | R | R | R | R |
| Andalusite | R | R | R | VR |
| Garnet | VR | R | VR | VR |
| Epidote | -- | VR | -- | R |
| Rutile | VR | VR | VR | VR |
| Sphene | -- | VR | -- | VR |
| Hypersthene | VR | -- | -- | -- |
| Gold | VR | -- | -- | -- |
| Glaucophane | -- | -- | VR | -- |
| Spinel | -- | -- | -- | VR |

A = abundant, C = common, R = rare, VR = very rare. Micaceous grains ranging from biotite through a series of alteration products are perhaps the most distinctive feature of these rocks. At least three products of alteration are discernible: vermiculite, chlorite, and anauxite. The heavier varieties are not present in Chaney Ranch 1, but anauxite is present; all varieties are common in Chaney Ranch 2 and 3; and all varieties present but not common in Chaney Ranch 4 and Escarpado Canyon "C".

"I feel that no conclusions regarding correlation between the Escarpado Canyon and Chaney Ranch Canyon samples can be based on the heavy-mineral assemblages. The outstanding difference between the two is the abundance of clinozoisite and epidote at Escarpado Canyon and their scarcity elsewhere but I don't think this is particularly significant. Andalusite is more scarce and a trace of spinel appears at Escarpado Canyon, but these differences are trivial. There is certainly as much variation among the different Chaney Ranch varieties as between them and the Escarpado Canyon rocks. As far as these analyses go, the two samples might well belong to the same formation or they might with equal probability be distinct."

January 26, 1941 Konrad Krauskopf

This sandstone lenses out into the brown shale of the Dos Palos shale member at Panoche Creek. Where the Cima sandstone is missing it is impossible to subdivide the Dos Palos shale; the top of the Moreno is placed at the top of the brown shale above the Cima when present in the section. The upper contact of the Moreno is, therefore, drawn at the top of the uppermost brown shale in Escarpado Canyon.

The upper brown shale above the Cima sandstone can be mapped north of Panoche Creek for a distance of $2\frac{1}{2}$ miles. At this point it is overlapped by the Domengine sandstone. The green glauconitic sandstone at the base of the Lodo formation progressively overlaps more and more of the upper brown shale member to a point near the southwest corner of sec. 5, T. 15 S., R. 12 E., where the Domengine sandstone, in turn, overlaps the green sandstone and more of the remaining brown shale. In Wedge Canyon, the Domengine sandstone with abundant *Turritella buwaldana* and characteristic black pebbles lies directly on the brown glauconitic shale of the upper Dos Palos shale member of the Moreno.

The faunas found in the lower part of the Lodo and lower Laguna Seca formations suggest a Paleocene age. Both of these formations are in disconformity with the underlying Moreno formation. In the last few years, the finding of Paleocene-like fossils in the Cima sandstone member of the Moreno has presented the possibility that the Paleocene Age-Time line ranges as low as the upper part of the lower Dos Palos member or several hundred feet down in the brown shale below the Cima sandstone, where *Valvulineria lillisi* or *Valvulineria pachecoensis* is found. At this horizon there is no field evidence of an orogeny of any kind. The Cima sandstone lenses out of the section and the whole upper part of the Moreno is transgressed by the overlying Lodo and Laguna Seca formations.

*General Description.* The Moreno formation comprises chiefly brown shale 1800 to 3200 feet thick whose lower and upper contacts are easily traced through the Panoche Hills. In the Moreno Gulch area the first thin streaks of brown shale of the Moreno occur immediately above the "tawny-weathering" sands mentioned by Anderson and Pack. These "tawny-weathering" sands are correlated in this paper with the micaceous, concretionary Cima sandstone of Escarpado Canyon. In both localities this sand includes thin brown shale streaks characteristic of the Moreno. In Escarpado Canyon the upper member, which is not present in Moreno Gulch, is 180 feet of brown, glauconitic, silty shale containing irregularly bedded concretions. The top of the Moreno is placed at the top of this glauconitic brown shale. The Cima sand lentil lenses out, leaving a thick indivisible brown shale, the Dos Palos shale member. The base of the Dos Palos is placed at the top of the white-weathering shale, the Marca shale member.

The Marca shale member is lithologically distinct, ordinarily contains white, hard, rounded, calcareous concretions at the top and base, and is a distinct aid in mapping the Moreno formation as a whole. This white-weathering member includes 300 feet of beds with abundant *Siphogenerinoides whitei* Church. Some of the white concretions contain a few poorly preserved megafossils. Underlying the Marca shale conformably is the Tierra Loma shale member totaling 1200 feet of brown shale. The only changes in lithologic character of the brown shale are numerous sandstone dikes. The Dosados sandstone and shale member is conformably below the Tierra Loma shale. Although variable, the Dosados sandstone and shale averages about 200 feet in thickness. Conformably below the Dosados member is the Panoche formation. The massive concretionary sandstone at the top of the Panoche makes the first steep ridge which is a natural break from the rounded topography of the Moreno shale. These several members of the Moreno shale can be traced southward from the type section across Panoche Creek, through the Ciervo Hills.

### LAGUNA SECA FORMATION

The Laguna Seca formation is herein recognized and named because it is a distinct lithogenetic unit that represents a particular environment of deposition. There is a practical and scientific need for a new name in the local sequence of sediments. It is a prominent cartographic unit

[5] In an attempt to find evidence for or against correlation of the Cima sand south of the Miocene overlap in Escarpado Canyon, with the sand mapped as Cima sand north of this point, as in Chaney Ranch Canyon, samples were sent to Konrad Krauskopf, Stanford University, for mineral analysis. Following is Konrad Krauskopf's report of January 26, 1941.

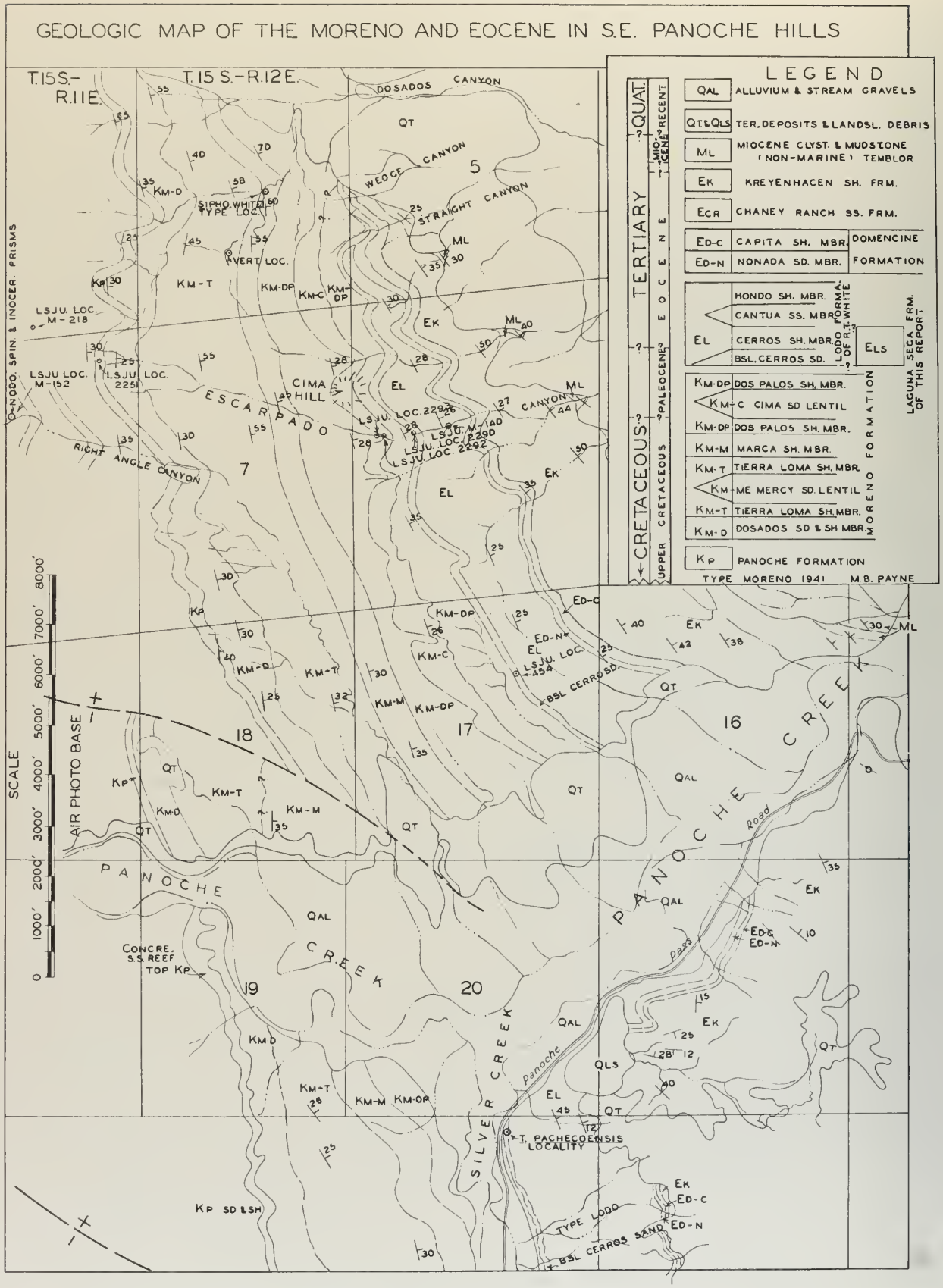


FIGURE 6. Geologic map of the Moreno and Eocene in SE Panoche Hills.

different from adjacent formations exposed near Reptile Canyon in the Panoche Hills and extending northward to Ortigalita Creek, a lateral extent of 18 miles. The formation is not the exact correlative of the Martinez formation and it cannot be traced into the type locality of the Martinez. Moreover, the physical characteristics of the two formations are not identical, and the sequence of sediments above and below the Laguna Seca is not the same as at the type Martinez section. The type Martinez locality is about 100 miles north of Laguna Seca Canyon. Between the two localities the Eocene immediately above the Cretaceous, as in Garzas Creek, is pinkish-white anauxitic sandstone wholly different in physical characteristics from the Laguna Seca formation. Nor can the Laguna Seca formation be mapped south into the type Lodo formation in Panoche Creek. The type Lodo formation consists of 1130 feet of gray clay shale and mudstone with the basal sandstone member containing some glauconite and the well-known *Turritella pachecoensis* fauna. The base of the Lodo formation north of Panoche Creek is represented by 80 feet of glauconitic sandstone containing concretions with fossils of Paleocene age. The Lodo can be mapped approximately 3 miles north of Panoche Creek, where the Domengine completely overlaps the Lodo and rests on the Dos Palos shale of the Moreno formation. The Temblor formation overlaps the whole section and rests on the Moreno a short distance north of this overlap and the section is thus covered. About 1 mile farther north, the Domengine can again be seen, however, and the upper glauconitic brown shale of the Dos Palos member of the Moreno is missing. Here the Laguna Seca formation lies on the Cima sandstone lentil of the Moreno.

A new name is proposed for this lithogenetic unit because: a) it is desirable that no misunderstandings arise about the unit here discussed, b) it is different in physical characteristics from any of the Eocene formations, either north or south, representing a distinct environment of deposition, c) paleontologic evidence is not conclusive to prove its complete contemporaneity with any other formation in this part of the section, d) it is mappable in as much area as shown in this paper, and e) it can not be traced into a previously named formation.

The "Martinez" (?) formation originally mapped by Anderson and Pack [6] in the area north of Panoche Creek includes the Lodo formation later described by White [7]. The Cima sandstone and the Laguna Seca sandstone of this paper were included in their "Tejon" (Domengine) as they could not prove the Paleocene age of any of the sandstones.

According to Anderson and Pack: [8]

"The small intermediate area in which the Martinez (?) is probably exposed, but in which its presence has not yet been definitely proved, is on the northeast flank of the Panoche Hills." ...

"North of Little Panoche Creek it has a maximum thickness of about 1100 feet and is a fairly uniform body of very fine-grained massive gray sandstone which contains fewer and less perfectly formed concretions than the Martinez (?) in the southern area and little if any interstratified dark clay shale. In the northern area the formation is fairly homogeneous throughout, and contains no well-defined lithologic members."

The Martinez (?) referred to by Anderson and Pack in the southern part of the area is the Lodo formation and is in no way similar to the sands they called Martinez (?) formation in the Moreno Gulch and Laguna Seca Creek areas.

Anderson and Pack [9] stated:

"All the Eocene beds along the northeast flank of the Panoche Hills are tentatively mapped as Tejon (Domengine), but it is probable that the Martinez (?) is represented by their lower portion on the northeast flank of the hills, a few miles south of Little Panoche Creek."

Sands of Paleocene age are present in the Panoche Hills, but their lower part, mapped as Tejon by Anderson and Pack, belongs to the Moreno formation and the upper part only belongs to the Laguna Seca sandstone formation.

*Definition.* The name Laguna Seca is taken from Laguna Seca Creek whose mouth is near the northeast corner of sec. 18, T. 12 S., R. 11 E., and drains diagonally across this section from the southwest corner. From here the creek may be followed upstream through the lower half of secs. 13 and 14, T. 12 S., R. 10 E., crossing the south line of sec. 14 near the south quarter corner and draining through the upper half of sec. 23, T. 12 S., R. 10 E. In the north branch of this canyon the Laguna Seca formation is well exposed throughout most if its thickness with only a few slides covering a small part of the section. The type locality is in the north branch of Laguna Seca Creek.

The Laguna Seca formation is a thick fine-grained, gray, massive, abundantly micaceous, concretionary homogeneous sand section, semi-platy in part. The concretions are very carbonaceous and ordinarily contain petrified wood with *Teredo* borings. Other fossils are found sparingly in the concretions.

The upper contact is 2100 feet north and 2700 feet east of the southwest corner of sec. 18, T. 12 S., R. 11 E., and the base is 1200 feet north and 1700 feet east of the southwest corner of sec. 18. The lower limit of the formation appears to be gradational. Areal geology, however, shows that this contact progressively transgresses northward upon lower members of the Moreno formation and is thus considered to be disconformable. The upper limit of the formation is taken at the top of the gray, massive, abundantly micaceous, friable sandstones and at the base of the fine-grained, gray Domengine sandstone containing hard, yellow concretions. The measured section of the Laguna Seca sandstone is 1120 feet.

The fauna of the lower Laguna Seca formation is Paleocene and in Laguna Seca Creek it contains the *Turritella pachecoensis* fauna approximately 300 feet above the base of the formation.

Laguna Seca sandstone is peculiarly distinct in containing very carbonaceous concretions enclosing numerous *Teredo* borings and poorly preserved fossils. Here and there hard platy reefs contain megafossils. Where the Laguna Seca lies directly on the Cima sandstone in the Panoche Hills, the Cima can be differentiated by the thin layers of brown shale, its general lithologic character, and the numerous concretions it contains.

### LODO FORMATION

R. T. White [10] placed the type locality of the Lodo formation in a small gulch on the east side of Silver Creek,

[6] Op. cit.

[7] White, Robert T., Eocene Lodo formation and Cerros member of California (abst): Geol. Soc. America Proc. 1937, pp. 256-257, June, 1938.

[8] Op. cit., pp. 58-59.

[9] Op. cit., p. 64.

[10] White, Robert T., Eocene Lodo formation and Cerros member of California (abst): Geol. Soc. America Proc., 1937, pp. 256-257, June, 1938.

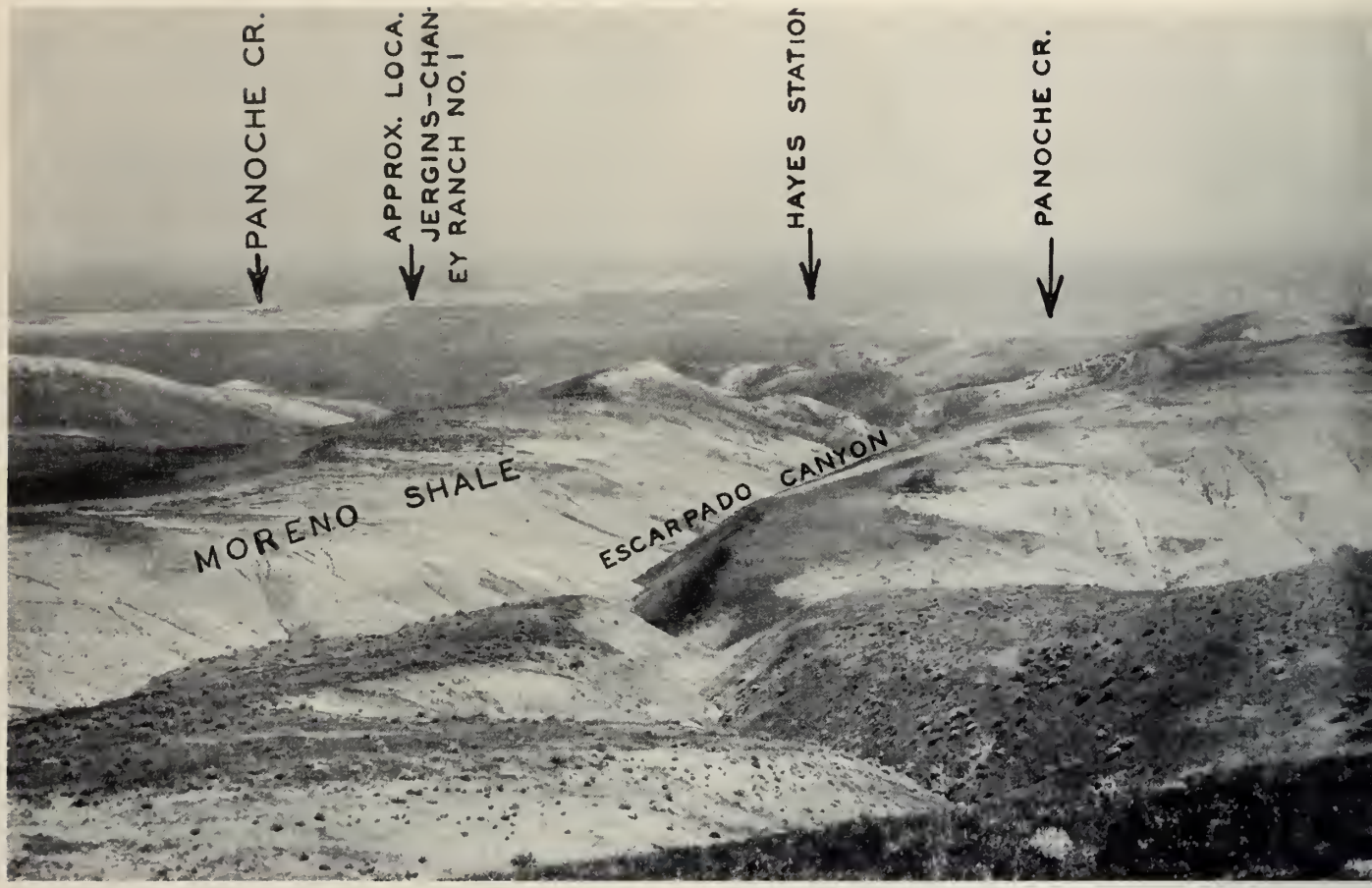


FIGURE 7. View east down Escarpado Canyon. Photo by H. G. Schenck, 1941.

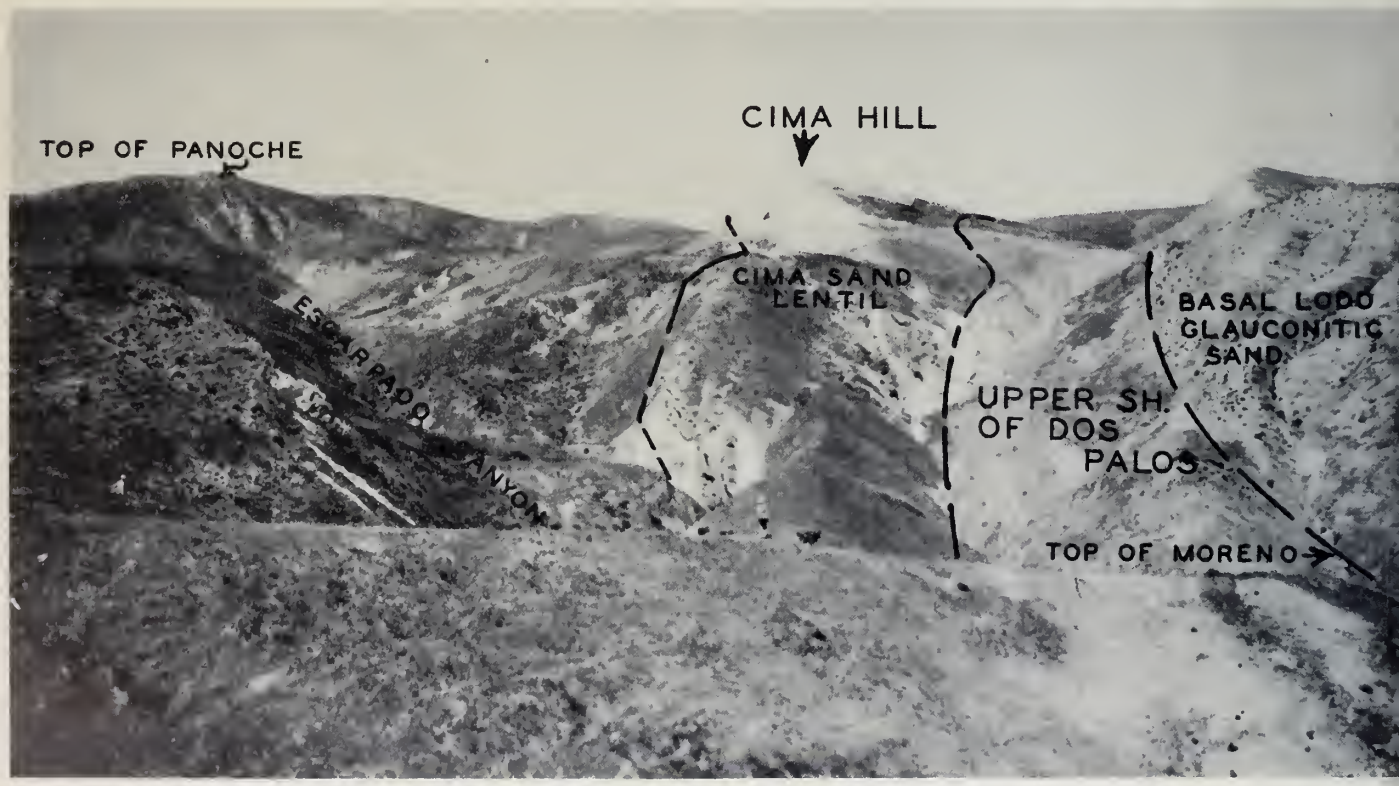


FIGURE 8. View N. 50° W. to the Cima sandstone in Escarpado Canyon. Photo by H. G. Schenck, 1941.

4000 feet south of its confluence with Panoche Creek, near the south line of the NE¼ sec. 29, T. 15 S., R. 12 E., M.D.M.

Reasons for correlating the beds called Lodo in the southeastern part of the Panoche Hills with the Lodo formation at its type section are: 1) the strata in the two localities have the same lithologic characteristics, 2) the shale is mappable from the southeastern part of the Panoche Hills to the type locality 4 miles south, 3) the sequence of sedimentary rocks above and below the formation found in the Panoche Hills is the same as in Lodo Gulch, and 4) the shale in the Panoche Hills contains the same foraminiferal faunas as those found in the lower part of the type Lodo formation.

The Lodo formation is present only in the southeastern part of the Panoche Hills. In Escarpado Canyon there are 428 feet of Lodo as compared with 1130 feet at the type locality. The 428 feet are a dark-gray to gray argillaceous shale and mudstone, with glauconite abundant in the lower part. In Straight Canyon, half a mile north, the gray Lodo shale above the basal green glauconitic sand is 25 feet thick and in Wedge Canyon, 400 feet north of Straight Canyon, it is missing. The Domengine overlaps the Lodo formation at a point 2000 feet north of the southwest corner of sec. 6, T. 15 S., R. 12 E.

### DOMENGINE FORMATION

B. L. Clark [11] redefined the Domengine formation in a restricted sense and pointed out the unconformity at the base of the pebble bed. The original description by F. M. Anderson [12] ("Tejon") included the gray shale unit above and the fine gray sand with the pebble bed at the base. Neither of these papers gave a detailed description of the contacts. R. T. White [13] defined the Yokut as a separate formation from the Domengine.

Notwithstanding several papers dealing with the Domengine and Kreyenhagen formations, geologists are still uncertain as to their exact rock-stratigraphic boundaries. This is due to the lack of precise descriptions, to attempts to correlate isolated outcrops at many different and widely separated localities, and to the indiscriminate use of rock-stratigraphic and time-stratigraphic terms. In a recent paper, Boris Laiming [14] affirmed that the foraminiferal zones have been known to transcend formation boundaries at several localities. It is well known that time lines do not necessarily parallel lithologic divisions. Additional paleontologic data and closer discrimination of species may later prove that strata are not contemporaneous. The conclusion seems to be warranted that the use of time-stratigraphic terms for local rock-stratigraphic units is undesirable; incomplete paleontologic evidence does not prove strata to be exact chronologic equivalents. The name Domengine is undesirable in a time or time-stratigraphic sense, since it is well established in the literature and in use as a rock-stratigraphic name. Therefore, the Domengine formation is defined in this paper as the beds stratigraphically below the glauconite at the base of the Kreyenhagen shale and above the Lodo formation. The Domengine includes the gray foraminiferal shale and the underlying gray sands down to the base of the pebble bed which rests unconformably on the Lodo formation in the southeastern part of the Panoche Hills. This is the sequence of sediments except for the restricted area where the Chaney Ranch sandstone formation is found in the outcrop; another exception to this sequence is just north of Cantua Creek where the basal Kreyenhagen glauconitic sand lies directly on the Yokut sand with the Domengine formation entirely missing in the outcrop. This white, anauxitic sandstone occurs below the Kreyenhagen and above the Domengine formation.

The Domengine formation comprises two separate and distinctly different cartographic units. The upper is a gray, foraminiferal shale member and the lower is a gray, yellow-weathering, fine-grained sandstone member which may include from one to six yellow, calcareous, pebbly and commonly fossiliferous sandstone "reefs". Separate names for the different members of a formation are desirable for precise understanding and description. According to recommended stratigraphic procedure, a member of a formation can not be given the same name as that of the formation. Therefore, two names are here proposed for the two members of the formation.

*Capita Shale Member.* The name Capita is given to the canyon that drains the southwest corner of sec. 19, the northwest corner of sec. 30, T. 14 S., R. 12 E., and the southeast corner of sec. 24, T. 14 S., R. 11 E., passing through the center of the north section line and through the northwest corner of sec. 25, T. 14 S., R. 11 E. *Capita* is a Spanish word meaning cape or cover. The type locality for the Capita shale member of the Domengine formation is in Chaney Ranch Canyon and the name is taken from Capita Canyon just south of Chaney Ranch Canyon.

At the type locality the member comprises 50 feet of homogeneous, gray shale which is firm, massive, micaceous, and in places carbonaceous. In Gres Canyon the member is more silty and sandy and is represented by a sand facies; farther north, as in Laguna Seca Canyon, the member is missing. The lower and upper contacts appear to be gradational with the adjacent formations. Among the many fossils in the Capita shale are *Turritella buwaldana, Exputens alexi,* and *Discocyclina* cf. *D. clarki.*

*Nonada Sandstone Member.* The Spanish word meaning low and flat (Nonada) is given to the hill 200 feet north and 800 feet west of the southeast corner of sec. 13, T. 14 S., R. 11 E. The friable Nonada sandstone is gray and fine-grained. The rounded grains are predominantly quartz, weathering to a yellow color. This member includes two calcareous and fossiliferous pebble "reefs" in the northeastern flank of the Panoche Hills. The lower and unconformable boundary is placed at the base of the lower pebble bed. The upper limit of this member is a conformable sand-shale contact. The measured thickness in the first (Capita) canyon south of Chaney Ranch Canyon in the Panoche Hills is 68 feet. Abundant molluscan fossils occur in this sand.

### CHANEY RANCH SANDSTONE

Chaney Ranch sandstone is a new formation name. It is given the rank of a formation because it can easily

[11] Clark, B. L., The Domengine horizon, middle Eocene of California: Univ. California, Dept. Geol. Sci. Bull., vol. 16, no. 5, pp. 99-118, 1926.

[12] Anderson, F. M., A stratigraphic study in the Mount Diablo Range of California: California Acad. Sci. Proc., 3d ser., Geol. vol. 2, pp. 115-248, 1905.

[13] White, Robert T., Eocene Yokut sandstone north of Coalinga, California: Am. Assoc. Petroleum Geologists Bull., vol. 24, pp. 1722-1751, 1940.

[14] Laiming, Boris, Foraminiferal correlations in Eocene of San Joaquin Valley, California: Am. Assoc. Petroleum Geologists Bull., vol. 24, pp. 1923-1939, 1940.

POSSIBLE AFFINITY AND CORRELATION OF THE CHANEY RANCH SAND WITH OTHER WHITE SANDS OF THE WEST SIDE AND THE VALLEY IN GENERAL LED TO HEAVY-MINERAL STUDIES OF THE SANDS IN GRES CANYON. THE CHART SHOWS THE RELATIVE POSITIONS OF THE SAMPLES AND THE DETERMINATIONS OF THEM MADE BY V. T. ALLEN.

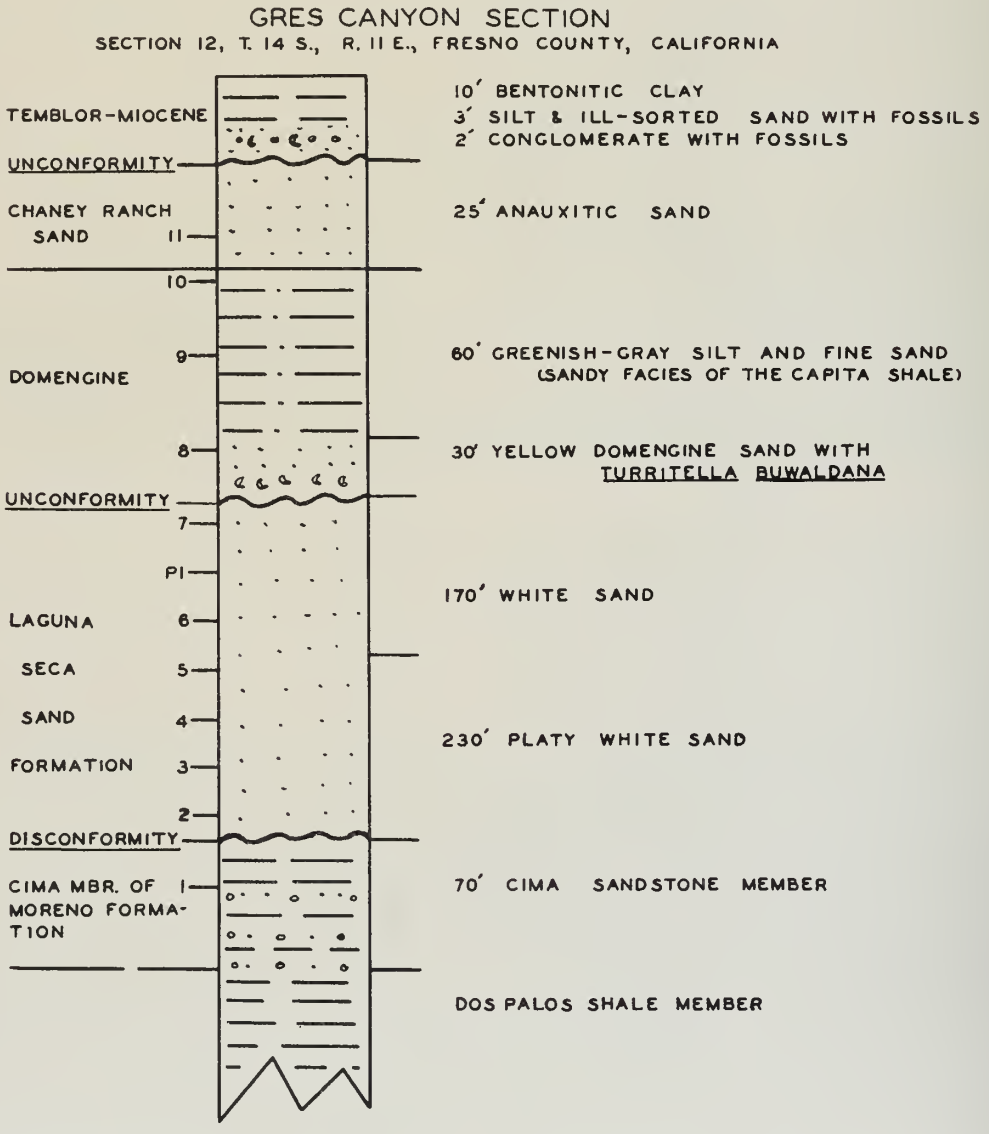


FIGURE 9. Gres Canyon section.

FIGURE 10. View NW across the mouth of Garzas Creek. The Eocene?-Garzas contact can be seen across Garzas Creek. Photo by Sam Wells, University of California.

be differentiated from adjacent formations by its physical characteristics, and because it lies between the boundaries of the Domengine and Kreyenhagen formations, which are adjacent in the Panoche Creek area.

The Chaney Ranch sandstone conformably overlies the Capita member of the Domengine formation and is disconformable below the glauconitic sand at the base of the Kreyenhagen formation. South of the Temblor overlap in the Panoche Hills, at the T. 14 S.-T. 15 S. line, the Kreyenhagen lies directly on the Capita shale. This is similar to the sequence south of Panoche Creek. North of Chaney Ranch Canyon toward Gres Canyon, the Temblor formation again overlaps both the Kreyenhagen and the Chaney Ranch sand. Only 20 feet of Chaney Ranch sand is present below the Temblor in Gres Canyon.

The name Chaney Ranch comes from the nearby ranch which has long been a landmark; the name appears on the topographic sheets of this area. The type section of the Chaney Ranch formation is in the canyon of this name in the northwest corner of sec. 19, T. 14 S., R. 12 E. Specific localities in Chaney Ranch Canyon where the formation is exposed are: the base of the glauconitic sand at the base of the Kreyenhagen and the top of the Chaney Ranch sandstone, 1900 feet south and 1050 feet east of the northwest corner of sec. 19; the base of the Chaney Ranch sandstone and the top of the Capita shale, 1950 feet south and 750 feet east of the northwest corner of sec. 19.

The sandstone is strikingly white in color, clean, friable, porous, and as far as known non-fossiliferous. Megascopically the rock appears to be made up entirely

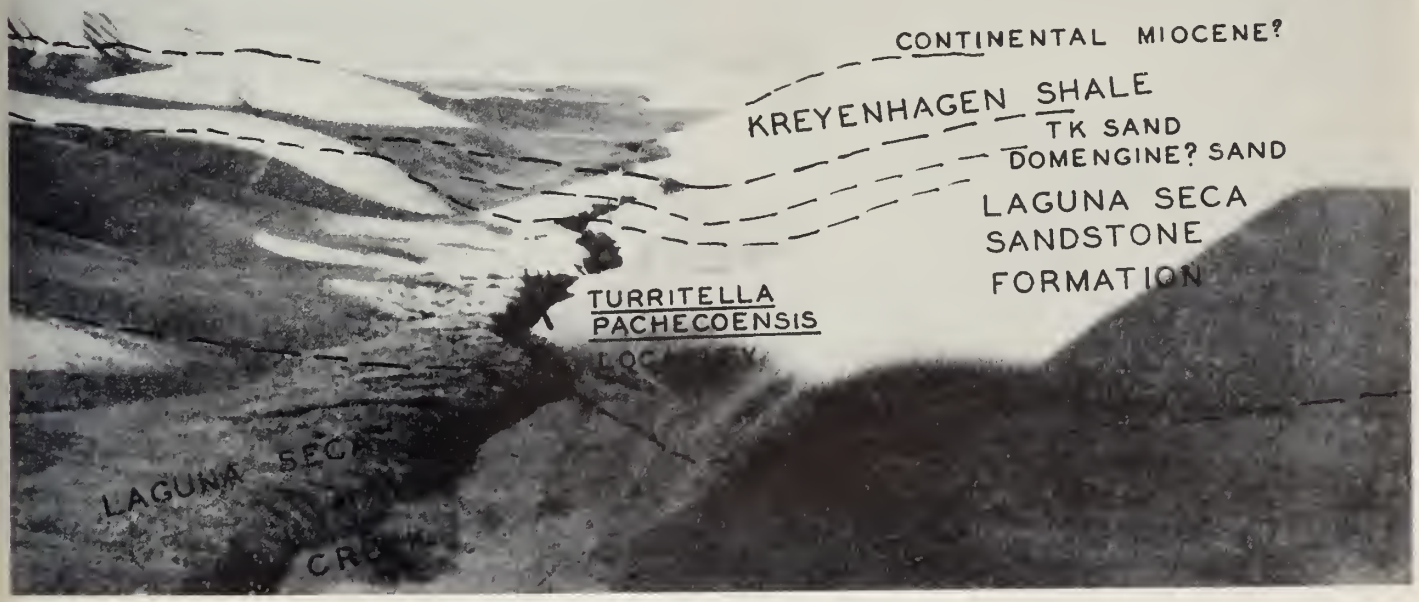


FIGURE 11. View east down Laguna Seca Creek.

*Analyses of sands.*

| | Gres Canyon | | | | Laguna Seca Canyon | | Chaney Ranch Canyon |
|---|---|---|---|---|---|---|---|
| | Cima sand | Laguna Seca sand | Domengine | Chaney Ranch sand | Kreyenhagen sand | Miocene sand | Chaney Ranch sand |
| | | | Nonada sand / Capita shale | | Merced County, Charleston School quadrangle, sec. 1, T. 11 S., R. 10 E., 550 ft. E., 800 ft. N. of SW corner of section. | Merced County, Charleston School quadrangle, sec. 12, T. 12 S., R. 10 E., 550 ft. S., 300 ft. W. of NE corner of section. | |
| Mineral | 1 | 2 3 4 5 6 7 | 8 / 9 10 | 11 | V.T.A. 61 | V.T.A. 62 | "X" |
| Zircon | x | x x x x x x | x / x | x | x | x | x |
| Pink andalusite | x | x x x x x x | / | x | x | x | x |
| Epidote | | x x x x x | x / x | x | x | x | x |
| Garnet | | x x x | x / x | | | | |
| Brown tourmaline | x | x x x x x | x / x | x | x OR | | x |
| Black tourmaline | | | / | | x | | |
| Green hornblende | | x | / | | | | x |
| Glaucophane | x | x | x / x | | | | x |
| Magnetite | | | / | | x | x | |
| Ilmenite | x | x x x x x x | x / x | x | | x | x |
| Leucoxene | x | x x x x x x | x / x | x | | | x |
| Rutile | x | x x x x | x / | x | x | x | x |
| Sphene | | x x x x | x / | | | | x |
| Biotite | x | x x x x x x | / | | | | |
| Muscovite | x | x x x x x x | / | | | | |
| Anauxite | | x x x x | / | x | x | | x |
| Vermiculite | x OR | | / | | | | |
| Amphibole | | | / | | | x | |
| Sillimanite | | | / | | | | Feldspar 37%<br>Quartz 60% |

x = present; OR = occasional to rare occurrence.

of quartz, scattered pink grains, and abundant white, wavy flakes of anauxite.

In the field the general appearance of the upper and lower contacts seems to indicate conformity. The lower limit is placed at the contact between the white anauxitic sand and the Capita shale below. The upper contact is taken at the base of the glauconite below the "salt-and-pepper" sand at the base of the Kreyenhagen formation. The sands at the base of the Kreyenhagen are characteristic and distinctive, as has been pointed out by Anderson and Pack.[15] The Chaney Ranch sand is not a facies of the Kreyenhagen or of the Domengine because it is beyond the recognized boundaries of these formations. Thus, although slight, there was probably some change of depositional conditions between the Kreyenhagen and Domengine; the relationship between the Chaney Ranch and adjacent formations is considered provisionally to be one of disconformity.

The measured thickness of the Chaney Ranch sandstone is 232 feet in the type section. It can be mapped from the center of sec. 30, T. 14 S., R. 12 E. northward to Gres Canyon near the N¼ corner of sec. 12, T. 14 S., R. 11 E., a lateral extent of 3½ miles. In Gres Canyon the Cheney Ranch sandstone is only 20 feet thick due to the Temblor overlap again crossing the section.

The age of the Chaney Ranch sandstone is post-*Cibicides (Truncatulina) coalingensis*, or *Amphimorphina californica* "zone," and pre-"*Plectofrondicularia*" *jenkinsi* "zone." This suggests that it is equivalent to part of the Markley sandstone and to part of the type Tejon.

[15] Op. cit.

## KREYENHAGEN SHALE

Anderson and Pack [16] stated that the name Kreyenhagen is appropriate for the beds in the Panoche Hills because they are the equivalent in age and lithology to the formation at its type area along Reef Ridge. Recent work has not altered this view. The Kreyenhagen shale may be mapped across Panoche Creek as far north as the Temblor overlap in Gres Canyon. A small area of Kreyenhagen appears in Chaney Ranch Canyon. In the Laguna Seca Creek area, it is again present and is about 700 feet thick. The reasons for using the term Kreyenhagen in this area are: 1) the physical characteristics and lithology are similar to the type section, 2) it is a cartographic unit from the Coalinga district (where Anderson and Pack demonstrated that it was the same as the Reef Ridge type section) to Panoche Creek area, and 3) the sequence of sediments is similar.

## TEMBLOR FORMATION

The Temblor is represented in the Panoche Hills by light greenish-gray clays and sandstones with a conglomerate at the base. In Panoche Creek the conglomerate is coarse, massive, and about 30 feet thick. In the canyons to the north various thicknesses of these sedimentary rocks with conglomerate at the base are found and are illustrated on the map. Terrace material covers and obscures most of these beds along the Panoche Hills but in Gres Canyon they crop out and are about 15 feet thick. The lower 3 to 4 feet contain a molluscan fauna.

[16] Op. cit.

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INDEX OF GEOGRAPHIC NAMES

Capita Canyon (sec. 19, T. 14 S., R. 12 E.)
Ceiros Hill (sec. 14, T. 16 S., R. 12 E.)
Chaney Ranch Canyon (sec. 18, 19, T. 14 S., R. 12 E.)
Cima Hill (sec. 8, T. 15 S., R. 12 E.)
Dosados Canyon (sec. 5, T. 15 S., R. 12 E.)
Escarpado Canyon (sec. 7, 8, 9, T. 15 S., R. 12 E.)
Gres Canyon (sec. 12, T. 14 S., R. 11 E.)
Laguna Seca Hills (T. 11, 12, 13 S., R. 10, 11 E.)
Lodo Gulch (sec. 29, T. 15 S., R. 12 E.)
Marca Canyon (sec. 13, 24, T. 14 S., R. 11 E., and sec. 18, T. 14 S., R. 12 E.)
Mercy Canyon (sec. 15, T. 16 S., R. 12 E.)
Nonada Hill (sec. 13, 24, T. 14 S., R. 11 E.)
Reptile Canyon (sec. 31, 32, T. 14 S., R. 12 E.)
Right Angle Canyon (sec. 12, T. 15 S., R. 11 E., and sec. 6, 7, 8, T. 15 S., R. 12 E.)
Straight Canyon (sec. 5, T. 15 S., R. 12 E.)
Tierra Loma School (sec. 9, T. 14 S., R. 12 E.)
Wedge Canyon (sec. 5, T. 15 S., R. 12 E.)

# APPENDIX A
# MEASURED SECTIONS

## SECTION 1

*Section of the Kreyenhagen shale formation in Chaney Ranch Canyon, sec. 19, T. 14 S., R. 12 E., M.D., Panoche quadrangle, Fresno County, California.*

| Terrace | Feet |
|---|---|
| White to gray, medium-grained, friable, massive sandstone containing a mixture of black and white grains | 20 |
| Gap [17] | 20 |
| Brown to dark-brown shale, containing gray, yellowish, and white layers; platy fracture; abundant radiolaria | 98 |
| Whitish gray, medium-grained, friable, poorly sorted, porous sandstone, containing abundant femic mineral grains | 22 |
| Buff-colored, silty, calcareous, thin-bedded, hard shale | 2 |
| White-gray, medium-grained, friable sandstone, containing many femic mineral grains | 2 |
| Buff, silty, hard, platy shale | 1 |
| White-gray, friable, medium-grained sandstone, containing many femic grains | 5 |
| Buff, silty, hard, platy shale | 1 |
| White-gray, friable, medium-grained sandstone with many femic grains | 4 |
| Buff, hard, platy, calcareous shale | 4 |
| White-gray, hard, medium-grained, well-cemented sandstone | 0.5 |
| White-gray, friable, medium-grained, massive, micaceous sandstone | 3.5 |
| White-gray, hard, medium-grained, quartzose sandstone, containing weathered mica | 0.5 |
| Buff, silty, hard, platy shale | 0.5 |
| White-gray, medium-grained, friable, massive sandstone, containing dark femic grains | 34 |
| Greenish-gray soft, massive mudstone, containing scattered sporbo | 2 |
| White-gray, friable, medium-grained, silty, apparently porous sandstone, containing scattered femic grains, and altered mica | 10 |
| Greenish-gray, friable, coarse, poorly sorted pebble bed, containing abundant glaucouite | 0.25 |
| | 230.25 |

Chaney Ranch sandstone.

## SECTION 2

*Section of the Chaney Ranch sandstone, sec. 19, T. 14 S. R. 12 E., M.D., Panoche quadrangle, Fresno County, California.*

Kreyenhagen sandstone (see section 1).

| | Feet |
|---|---|
| White-gray, friable, platy to poorly bedded sandstone, containing many femic mineral grains, and abundant silvery-white flakes of anauxite | 5 |
| White, clean, porous, fine-grained, crumbly sandstone, containing abundant anauxite | 5 |
| Buff to pinkish-gray, firm siltstone, containing gypsum streaks and abundant anauxite | 10 |
| White, friable to very crumbly, massive, very fine-grained, silty, clean and porous sandstone, containing carbonaceous material and abundant anauxite | 30 |
| Buff to brown, fine-grained, firm to hard, concretionary sandstone | 1 |
| White, fine-grained, friable to very crumbly, silty, massive sandstone, containing carbonaceous material and abundant anauxite | 29 |
| Pinkish-white, friable, massive, very fine-grained, clean, porous sandstone, containing abundant pink grains and abundant anauxite | 5 |
| Dark-gray, fine-grained, silty, friable sandstone, containing anauxite | 2.5 |
| White, fine-grained, friable, massive, silty, clean, porous sandstone, containing abundant anauxite | 80.5 |
| Brownish-red, iron-stained, firm siltstone, containing common gypsum streaks | 0.5 |
| Gray to pinkish-gray, sandy, poorly sorted, friable, massive siltstone, stained with red ocher and containing gypsum layers, abundant anauxite and small indeterminate megafossils | 32.5 |
| Gray, fine- to medium-grained, friable, massive, clean sandstone | 0.5 |
| Gray, firm, massive siltstone, containing red ocher streaks, hard gypsum layers, and common anauxite | 0.5 |
| White-gray, fine-grained, friable, clean, porous sandstone, containing abundant anauxite | 1 |
| White, poorly sorted, friable siltstone, containing anauxite | 1 |
| Grayish-buff, fine-grained, friable, massive, clean, porous sandstone | 2 |
| White-gray, fine-grained, firm, massive siltstone | 6 |
| Gray, silty, firm, tough, massive, anauxitic claystone | 5 |
| White, fine- to medium-grained, soft, crumbly, poorly sorted, massive, quartzose, clean, porous sandstone | 10 |
| Gray, poorly sorted, friable, massive siltstone, containing red iron-stained streaks and common gypsum layers | 2 |
| Gray to buff, silty, fine-grained sandstone, containing hard concretionary layers and common anauxite | 0.5 |
| Gap | 2.5 |
| | 232 |

In contact with Capita shale, which is gray, silty, massive, micaceous, and firm, containing abundant Foraminifera, *Discocyclina* sp., and *Exputens alexi*.

[17] Lithology not apparent at surface.

### SECTION 3

*Section of the Capita shale in Chaney Ranch Canyon, sec. 19, T. 14 S., R. 12 E., M.D., Panoche quadrangle, Fresno County, California.*

**Chaney Ranch sandstone contact.**

| | Feet |
|---|---|
| Gray, silty, firm, massive, micaceous claystone, containing abundant well-preserved Foraminifera and megafossils, including *Exputens alexi* and *Discocyclina* sp. | 25 |
| Gray, sandy, firm to friable, micaceous, massive claystone, containing abundant *Discocyclina* sp. | 5 |
| Gray, firm, clayey, micaceous siltstone, with a 2-inch gypsum layer at base | 5 |
| Gray, silty, firm, massive, micaceous claystone, containing common carbonaceous material; Foraminifera, including abundant *Discocyclina* sp.; and small megafossils. A 6-inch fine, gray sand reef at center of bed contains abundant *Turritella buwaldana* | 15 |
| | 50 |

**Soil cover.**

**Note: The lower contact of the Capita shale with the Nonada sandstone can be seen in Capita Canyon to the south.**

### SECTION 4

*Section of the Nonada sandstone member of the Domengine formation in Capita Canyon, sec. 19, T. 14 S., R. 12 E., M.D., Panoche quadrangle, Fresno County, California.*

**Terrace.**

| | Feet |
|---|---|
| Gray, massive, slightly silty and sandy shale, containing abundant well-preserved Foraminifera, and *Exputens alexi*, and with several irregular gray limestone concretionary layers in the lower part | 40 |
| Gray, muddy, soft siltstone, containing brilliant red and violet iron-stained streaks, occasional yellow hard limestone concretions, and with gypsum layers throughout | 2 |

**Base of the Capita shale member.**
**Top of the Nonada sandstone member.**

| | |
|---|---|
| Yellow-buff, friable, well-sorted, fine-grained, clean, well-washed sandstone, containing common dark femic mineral grains and scattered limestone concretions | 3 |
| Sandstone; 1 foot at top and 1 foot at base encased in many gypsum layers, middle 1 foot fine, friable, well-sorted, yellow-buff, massive sandstone; many sizes of yellow limestone concretions irregularly distributed; fossils locally abundant; vivid red and purple irregular stains | 3 |
| Dark-gray, massive, soft, crumbly silt, containing scattered small dark femic grains, small mica flakes, and purple-stained streaks | 3 |
| Yellow-buff, very fine-grained, silty, muddy sandstone, locally rust colored and streaked with gray | 1 |
| White, very fine, well-washed, porous, friable sandstone, containing abundant very small dark grains | 2 |
| Yellow, fine, platy sandstone, containing *Turritella buwaldana* | 1 |
| White, yellow-weathering, fine, friable, hard sandstone, containing fossils | 3 |
| Gap | 40 |
| Yellow, indurated sandstone, forming an irregular reef and containing common gypsum and abundant fossil borings and fragments. Fossils include *Turritella buwaldana*, pelecypods, and gastropods. Lower 1 foot soft, fine, well-sorted, and massive | 3 |
| Indurated, fine- to medium-grained, concretionary sandstone, containing abundant coarse sand grains and pebbles, and very abundant fossils including *Turritella* and *Venericardia* | 2 |
| Yellow-buff, very fine-grained, massive, soft sandstone, containing firm to hard layers, common black carbonaceous material, and very abundant fossils, including *Turritella* | 2 |
| Yellow-colored, calcareous, indurated, pebbly, poorly sorted, 2 to 3 foot irregular concretionary bed, forming a sandstone reef and containing very abundant fossils including *Turritella* and *Venericardia* | 2 |
| Massive, somewhat indurated, fairly crumbly, quartzose conglomerate, containing black to light-colored pebbles, and chert pebbles | 1 |
| | 108 |

**Base of Nonada sand member of the Domengine formation.**

**Top of Laguna Seca sandstone member.**

### SECTION 5

*Section of the Lodo shale formation in Escarpado Canyon, sec. 8, T. 15 S., R. 12 E., M.D., Panoche quadrangle, Fresno County, California.*

**Upper contact with Nonada sandstone member of the Domengine formation.**

| | Feet |
|---|---|
| Brownish-gray, tough, massive, slightly silty claystone, containing Foraminifera, common gypsum; the lower 5 feet is firm and clayey | 20 |
| White to buff, fine-grained, friable, massive, silty, micaceous sand, containing common rounded femic grains. The upper 3 feet are iron-stained and the lower 1 foot has common fossil borings | 4 |
| Green-gray to brown-gray, firm, massive claystone, slickensided in part and containing common gypsum layers | 15 |
| Yellow-gray, firm, friable, fine sandy, massive, siltstone containing abundant gypsum | 4 |
| Dark-gray to green-gray, massive, firm claystone, containing gypsum layers | 2 |
| Gap, stream deposit | 25 |
| Dark-gray to purplish-gray, firm, massive, micaceous, fine sandy siltstone | 20 |
| Very dark to black, massive claystone, containing occasional 1 foot steel-gray calcareous concretions | 7 |
| Gray-brown to purple-brown, firm to crumbly, massive, fine sandy, micaceous siltstone | 3 |
| Gap, stream deposit | 10 |
| Dark-gray to gray-brown, firm, massive to poorly platy, fine sandy, micaceous siltstone, containing gypsum and carbonaceous layers, Foraminifera, and plant remains | 150 |
| Buff, very fine, friable, massive, micaceous sand | 0.5 |
| Dark-gray to buff-gray, hard, massive, locally silty claystone, containing thin sandy streaks, carbonaceous material, and common gypsum | 6.5 |
| Gray, soft to friable, very fine, massive, micaceous sand | 1 |
| Dark-gray, hard to tough, finely sandy, massive claystone, containing rare small borings | 0.5 |
| Gray to yellowish-white, very fine, friable to loose, micaceous, massive sand, containing rare femic mineral grains, carbonaceous material, and an occasional gypsum layer | 1.5 |
| Dark-gray to gray-brown, firm, massive, poorly sorted, fine sandy siltstone | 2 |
| Dark-gray, firm, massive, micaceous claystone, containing abundant well-preserved Foraminifera | 3 |
| Gray, indurated, massive siltstone shell | 0.5 |
| Dark-gray, firm, massive, micaceous claystone, containing abundant well-preserved Foraminifera | 4.5 |
| Gray to gray-brown, firm, massive, very micaceous siltstone, containing abundant Foraminifera | 42 |
| Gray to brown-gray, firm to friable siltstone and interbedded sand. The sands are fine-grained and micaceous and there are Foraminifera in the silt layers | 17 |
| White to gray, very fine, friable, massive to thin bedded, micaceous sand, containing occasional hard siltstone concretions | 4 |
| Dark-gray, firm, massive claystone, containing occasional fine gray sand layers | 7 |
| Buff-gray interbedded massive siltstone and very fine, friable, massive to thin-bedded, micaceous sand | 45 |

| | Feet |
|---|---|
| Gap | 10 |
| Buff to gray, very fine, friable, massive, micaceous interbedded sand and siltstone containing carbonaceous material | 7.5 |
| Dark-gray, soft, slightly silty, micaceous claystone, with thin, fine gray sand streaks in middle | 1.5 |
| Gray to buff, friable, fine-grained, micaceous, indurated, concretionary sand, containing occasional ocher stains and concretions | 1 |
| Dark-gray, soft, micaceous, crumbly claystone, containing Foraminifera | 4 |
| Gray, friable, fine-grained, micaceous, carbonaceous sand, containing occasional calcareous concretions | 1 |
| Dark-gray, soft, silty, micaceous claystone, containing scattered glauconite and gypsum | 8 |
| | 428 |

**Basal glauconitic standstone.**

## SECTION 6

*Section of the upper Dos Palos shale member of the Moreno formation in Escarpado Canyon, sec. 8, T. 15 S., R. 12 E., M.D., Fresno County, California.*

**Lodo formation, gray, firm, silty, argillaceous, micaceous siltstone, containing Foraminifera.**

| | Feet |
|---|---|
| Gray-brown, firm, silty, micaceous shale | 17 |
| Dark-green, white weathering, fine sandy, firm to friable, argillaceous siltstone, containing very abundant glauconite and gypsum layers near the middle | 6 |
| Brown, firm, massive, micromicaceous, silty, occasionally carbonaceous shale | 10 |
| Gap | 5 |
| Dark chocolate-brown, rather soft, massive, slightly silty shale | 9 |
| Gap | 8 |
| Brown, fairly firm, slightly silty, micaceous, massive to poorly bedded shale | 18 |
| Gap | 10 |
| Dark-brown, fairly firm, massive, slightly silty shale | 7 |
| Gap | 5 |
| Shale, same as above but with fine sandy beds | 10 |
| Gap | 10 |
| Dark gray-brown, firm to hard, massive, slightly silty, shale, in places with a purplish or reddish cast, and containing Foraminifera | 35 |
| Dark purplish-gray, gritty, firm, massive shale, containing abundant glauconite in thin layers | 35 |
| Dark gray-brown to gray-brown, firm, massive, slightly silty, slightly micaceous shale, containing rare carbonaceous material and abundant glauconite | 10 |
| | 195 |

**Gray-brown, concretionary, firm, massive, somewhat clayey, micaceous Cima sandstone lentil of the Dos Palos shale member of the Moreno formation. It contains rare carbonaceous material.**

## SECTION 7

*Section of Cima sandstone lentil of the Dos Palos shale member of the Moreno formation, sec. 8, T. 15 S., R. 12 E., M.D., Escarpado Canyon, Fresno County, California.*

**Gray-brown, firm, massive, slightly micaceous, glauconitic upper Dos Palos shale of the Moreno formation.**

| | Feet |
|---|---|
| Gray-brown, very fine, silty, firm to hard, massive, somewhat clayey, micaceous, concretionary sandstone, containing rare carbonaceous material and fossil fragments. It is nonporous in part and in places is cemented with calcareous material | 20 |
| Brown-gray to purplish-gray, firm to hard, massive, micaceous, vermiculitic sandstone, containing megafossil casts and a 1-inch coal layer | 15 |
| Gray-brown to purplish-gray, firm standstone, containing vermiculite, and rare carbonaceous material. There is an irregular concretionary layer at the center and the lower 5 feet are chocolate brown and clayey | 20 |
| Brownish to purplish-gray, very fine and silty, massive, tough, argillaceous sandstone, containing vermiculite, carbonaceous material, and scattered "cannonball" concretions | 30 |
| | 85 |

**Brown shale of the lower Dos Palos shale member of the Moreno formation.**

**Gradational contact with very abundant rounded small concretions reaching 1 foot in diameter. The concretions gradually disappear and the shale becomes less silty downward.**

## SECTION 8

*Section in Gres Canyon, Panoche Hills, sec. 12, T. 14 S., R. 11 E., M.D., Fresno County, California.*

**Terrace material**

**Continental Miocene beds**

| | Feet |
|---|---|
| Green-gray, massive, silty and fine sandy, bentonitic (?) claystone | 10 |
| White, silty and muddy, poorly consolidated, poorly sorted sand, containing abundant fossils | 1 |
| Green, muddy, sandy silt containing fossils in soft massive silt | 2 |
| White, muddy, coarse, only fairly well consolidated conglomerate, varying from coarse sand to pebbles and boulders, and including *Pecten andersoni* and associated fauna | 2 |
| | 15 |

*Chaney Ranch sandstone formation.*

| | |
|---|---|
| White, fine- to medium grained, anauxitic, friable, clean, porous, sandstone, containing a few scattered dark grains | 25 |
| | 25 |

*Capita shale member of the Domengine formation.*

| | |
|---|---|
| Green-gray, white-weathering, friable, muddy silt, containing a few mica flakes and dark mineral grains; the upper 1 foot is a purple color and the half a foot below it is yellow-buff in color | 8 |
| Yellow-buff, very fine, firm to hard, calcareous sandstone, containing gypsum layers and concretions | 1 |
| Green-gray, soft to friable, muddy silt, containing rather common mica; the middle 1 foot is purple to violet colored | 4 |
| Green-gray, white weathering, muddy silt, containing some mica and forming a firm to hard calcareous reef; the upper 1 foot is yellow-buff | 5 |
| Yellow-buff, very fine, firm to hard sandstone, calcareously cemented | 0.5 |
| Greenish-gray, soft to friable, muddy, massive silt | 8.5 |
| Yellow-buff, calcareous, firm sandstone, containing common gypsum layers | 1 |
| White-gray to greenish-gray, very fine, clean, friable silt, containing pink to red-stained streaks | 12 |
| Gray to yellow, soft to friable shale, containing buff, green, lavender and red streaks, fine sandy silt layers; and is muddy and clayey locally. The upper half a foot is a calcareous hard buff reef | 20 |
| | 60 |

*Nonada sandstone member of the Domengine formation.*

| | |
|---|---|
| White-gray, fine silty sandstone with a green cast, and containing sub-rounded grains; the upper 1 foot is a calcareous yellow-buff reef of gypsum layers and soft to firm, fine-grained sand | 10 |
| Yellow to buff, fine, silty, slightly micaceous, hard, calcareous sandstone, containing fossils | 2 |

| | Feet |
|---|---|
| Green-gray, fine, silty, soft sandstone, with red iron stains | 2 |
| Yellow-buff to rust-colored, fine-grained, silty, slightly micaceous sandstone containing sub-rounded grains, small, dark to black, rounded grains, abundant gypsum layers, and thin calcareous concretionary layers | 15 |
| Yellow-buff-gray, firm, calcareous, irregularly concretionary sandstone, varying in thickness from a few inches to 2 feet, and containing gypsum layers, *Turritella buwaldana*, and other mollusks | |
| | 29 |

*Laguna Seca sandstone formation.*

| | |
|---|---|
| White, fine-grained, silty in part, soft to friable sandstone, containing common femic mineral grains and wavy dark mica flakes | 60 |
| Yellow to buff, concretionary, firm to hard, irregular sandstone, containing abundant dark green to black mica with a wavy texture | 1 |
| White, fine-grained, soft to friable, clean and porous to silty and only fairly well-washed sandstone, containing green to black wavy mica flakes, and common dark mineral grains | 70 |
| White, fine-grained, soft to friable sandstone, containing red to violet stains and a few scattered concretions | 21 |
| Soft, white to dark gray, friable sandstone and silt containing abundant mica with irregular platy, yellow-buff concretionary layers ranging from 1 foot to several feet thick, and containing abundant mica and dark femic minerals | 15 |
| White, massive to thin-bedded, friable sandstone, containing yellow and buff layers and common mica and femic grains. The upper 2 feet are dark gray, massive, micaceous, muddy, soft silt, containing vivid red-colored streaks, gypsum layers, and small occasional concretions | 20 |
| Yellow to buff, fine-grained, thinly bedded, firm to hard sandstone, containing abundant mica and some gypsum layers | 1 |
| Green-gray, massive, soft, red and violet, abundantly micaceous, muddy siltstone, containing irregular-colored streaks | 7 |
| Fine, thin-bedded sandstone, thinly streaked with yellow-buff and violet colors, and containing gypsum layers and some concretionary layers with platy, firm, fine-grained, abundantly micaceous sand | 1 |
| White, friable to soft, fine-grained sandstone, containing abundant mica and femic grains. The upper 1 foot is a dark-gray, muddy and micaceous silt, containing yellow and buff-colored streaks | 6 |
| Concretionary, calcareous, hard, fine, micaceous, irregularly bedded sandstone, thin-bedded in part | 1 |
| White, soft and friable, fine-grained, micaceous, thin-bedded to massive, poorly washed sandstone, containing common femic grains and common green mineral grains. The upper 1 foot is dark gray, muddy, micaceous silt | 12 |
| Firm to hard, fine-grained, silty sandstone, containing abundant mica and dark grains, occasional concretionary layers coated and interspersed with gypsum layers | 1 |
| Purple to lavender, massive, soft and crumbly, silty and micaceous mudstone, containing gypsum layers and scattered sand grains | 5 |
| White, friable, fine-grained, thinly bedded, soft sandstone, containing abundant mica and femic mineral grains | 5.5 |
| Yellow-buff, thin-bedded, firm sandstone, includes small concretions and gypsum | 0.5 |
| White, fine-grained, fairly clean and porous, micaceous, friable, massive sandstone, containing common femic grains | 8 |
| White, fine-grained, fairly clean, friable, massive sandstone, locally yellow- to brilliant red-colored, and containing several irregular concretionary reefs with abundant gypsum at top | 14.5 |
| Yellow-buff, firm to friable sandstone reef, containing very abundant green to black micas | 0.5 |
| Thin-bedded, friable, and easily weathered silt. There are fine silt and fine sand layers and occasionally a gray muddy silt layer | 10 |
| Buff sandstone layer containing gypsiferous concretions and abundant mica and dark grains | 1 |
| White, fine-grained, friable sandstone, silty in part and containing sub-angular grains, some irregular 1-foot concretionary layers, common mica, and femic grains | 15 |
| Gap | 5 |
| Yellow-buff, platy, fine-grained, friable sandstone, containing abundant mica | 5 |
| White, fine-grained, soft-weathering, micaceous sandstone, containing silty streaks, dark femic grains, and gypsum layers | 10 |
| Gap | 25 |
| White, fine-grained, silty, friable sandstone, porous in part, and containing common mica | 5 |
| Gray to buff, platy, fine-grained sandstone, containing very abundant mica | 1 |
| White, fine-grained, silty sandstone, containing scattered femic grains, common mica, and porous streaks; there is half a foot of muddy, gray, clayey layers near the middle, and a few scattered poorly developed concretions | 10 |
| Buff, fine-grained, platy, friable sandstone, containing very abundant mica flakes from white and green to dark in color. It has yellow-buff concretions as much as 2 feet thick | 2 |
| Gap, soil cover | 45 |
| White, fine-grained, clean and porous to silty and friable, micaceous sandstone, containing scattered femic minerals and buff and yellow stained silty layers and silt streaks | 15 |
| Gray, fine-grained, hard, platy, micaceous sandstone | 1 |
| White, fine-grained, friable sandstone, containing a few femic grains | 5 |
| Gray, platy, hard, indurated sandstone, which splits into thin plates | 1 |
| | 406 |

*Cima sand lentil of the Dos Palos member of the Moreno formation.*

| | |
|---|---|
| Brown to chocolate-brown, silty, micaceous, firm to crumbly shale, with a rounded fracture, and containing yellow and gray streaks and thin silt and sand layers | 10 |
| Gray to buff, fine-grained, hard and calcareous, concretionary, irregular-bedded, gypsum shell-covered sand | 1 |
| Brown to chocolate-brown, rather muddy, massive shale; silty, with dark mineral grains and small micaceous flakes, and containing gray streaks; silty and fine sandy streaks, fine sand and silt layers; two irregular concretionary, calcareous, yellow-buff to gray colored gypsum shell-covered reefs | 15 |
| An irregular concretionary layer of yellow to buff, hard, calcareous, fine, micaceous sand, commonly covered with a gypsum layer | 1 |
| Brown to chocolate-brown, silty, crumbly, micaceous shale, containing gypsum layers, yellow and gray-colored streaks, thin sand and silt layers, and common mica | 12 |
| Irregular, yellow and buff, micaceous sand bed, of fine- to medium-grained, hard, calcareous reefs and soft white sand. It contains abundant gypsum and has a cavernous gypsum covering which is commonly exposed | 2 |
| Brown to chocolate-brown, crumbly, fine sandy, silty shale with gray streaks, thin sand and silt layers, gypsum layers and streaks, and black femic mineral grains and mica | 5 |
| Buff to yellow-gray, calcareous, compact, fine-grained, micaceous sand, containing gypsum layers and forming an irregular concretionary reef | 1 |
| Brown to chocolate-brown, crumbly, silty, micaceous shale | 2 |
| Concretionary, hard, buff, calcareous, fine- to medium-grained, somewhat platy but irregular sand, containing gypsum layers | 1 |

| | Feet |
|---|---|
| Soft, fine-grained, silty gray sand with a green stain | 2 |
| Firm, silty and fine sandy gray shale with brown streaks | 2 |
| Yellow-buff, medium grained, concretionary sand, containing abundant light to green colored mica, and firm to hard gypsum layers | 3 |
| White-gray, silty, friable, fairly porous sand, containing light green and yellow stains, few micas, angular grains, and abundant dark femic mineral grains | 5.5 |
| Brown to chocolate-brown, silty and micaceous, massive, muddy and crumbly shale | 1 |
| Red, silty, friable, muddy shale, containing abundant white and light-colored micas. The upper half is a buff color | 0.5 |
| White-gray, fine-grained, friable, irregularly concretionary, silty sand, containing yellow-buff layers, angular grains, and common micas of several shades of color | 4 |
| Gray to buff, irregularly concretionary, friable sand with hard gypsum layers | 1 |
| | 69 |

**Lower contact is with the lower Dos Palos shale member of the Moreno formation, which is characteristically brown, massive, crumbly, finely silty, has local mica, gypsum layers, "cannonball" concretions, and larger concretions of calcareous, silty, fine-grained sand.**

Total thickness of section described 604

## SECTION 9

*Section of the Mercy sandstone lentil of the Moreno shale formation in the type section, sec. 15, T. 16 S., R. 12 E., M.D., Panoche quadrangle, Fresno County, California.*

**Upper contact with the upper Tierra Loma shale member of the Moreno.**

| | Feet |
|---|---|
| Yellowish-gray, fine- to medium-grained, friable sandstone, with occasional soft, carbonaceous, gypsum-coated concretions, interbedded with 1 foot to 2 feet shale beds which are brown to black in color, slightly silty and micaceous, massive to poorly bedded, and with common gypsum | 30 |
| Brown to chocolate-brown, massive to semi-platy, slightly silty shale, containing light-brown to black streaks, and common gypsum layers | 5 |
| Gray, fine, friable, angular-grained sandstone, containing abundant dark grains, and scattered concretions | 28 |
| Dark-brown to black, semi-platy, silty shale | 2 |
| Gray, fine-grained, massive, friable sandstone, containing femic mineral grains | 15 |
| Gray, fine- to medium-grained, massive, friable sandstone; it is poorly sorted with some large grains | 5 |
| Brown to black, slightly silty and micaceous, semi-platy, shale, containing thin light-brown weathered streaks and rounded fractures | 5 |
| Gray, fine- to medium-grained, friable, angular sandstone, containing abundant dark grains, and a few scattered micas | 20 |
| Brown to black, firm, massive to semi-platy, slightly silty shale, containing rounded platy fractures interbedded in 1 to 3 foot beds with whitish-gray, fine- to medium-grained, partly poorly sorted sandstone, containing numerous colored mineral grains | 20 |
| Whitish-gray, fine to coarse, poorly sorted, friable sandstone, containing common dark grains | 20 |
| Chocolate-brown to black, semi-platy, slightly silty, firm shale, containing fish scales and Foraminifera | 3 |
| Fine- to medium-grained, poorly sorted, friable, locally thin-bedded, concretionary, medium-grained, brown-weathering, sandstone, containing scattered dark, black, red, and green angular grains, and a few scattered small micas | 35 |
| | 188 |

**Lower contact with the lower Tierra Loma shale member of the Moreno formation.**

## SECTION 10

*Section of the Laguna Seca sandstone formation at the type section, north branch of Laguna Seca Canyon, sec. 18, T. 12 S., R. 11 E., M.D., Charleston School quadrangle, Merced County, California.*

**Yellow, calcareous, ferruginous "reefs" of the Domengine formation.**

| | Feet |
|---|---|
| Gray to brown-gray, tough, massive, argillaceuos, micaceous, iron-stained siltstone, containing rare carbonaceous material, common ocher, and gypsum and yellow sulphurous layers | 50 |
| Gray, fine, indurated, massive, dense, well-cemented sandstone, containing common femic minerals and abundant gypsum | 5 |
| Gray to brownish-gray, soft to tough, massive, argillaceous, micromicaceous, fine sandy siltstone, containing some gypsum and carbonaceous layers, and plant remains | 40 |
| Gray, indurated, massive, fine-grained, poorly sorted sandstone | 1 |
| Gray to brown-gray, soft, massive, finely sandy, tight siltstone | 4 |
| Dark-gray to brownish-gray, tough to firm, massive mudstone, containing common silty, iron-stained, and carbonaceous layers | 20 |
| Gray to brownish-gray, massive, tough to firm, micaceous, finely sandy, somewhat muddy and clayey siltstone, with rare shaly layers | 20 |
| Gray to buff-gray, very fine, silty, massive, micaceous, friable sandstone, containing irregular concretionary beds and abundant femic minerals | 75 |
| Gap | 7 |
| Gray to buff-gray, fine-grained, friable, massive sandstone, containing abundant mica and femic grains | 53 |
| Gap | 20 |
| Gray to buff-gray, fine-grained, friable, massive, micaceous sandstone, containing gypsum layers, concretionary layers, petrified wood in concretions, and occasional fossil fragments | 55 |
| Gap | 33 |
| Gray, buff-weathering, fine-grained, friable, silty sandstone, containing abundant mica and numerous irregular concretionary layers of brown, calcareous-cemented, gypsiferous sand | 32 |
| Gap | 15 |
| Gray to buff, fine-grained, friable, massive, silty, micaceous, fairly well-cemented sandstone, containing carbonaceous material, concretions containing poorly preserved megafossils, and pertified wood with *Teredo* borings | 70 |
| Gap | 10 |
| Gray, fine-grained, friable, massive, silty, micaceous sandstone, with concretions containing petrified wood and poorly preserved megafossils | 65 |
| Gap | 20 |
| Sandstone, same as above with hard concretionary layers at top and base | 20 |
| Buff-gray to light-brown, firm, massive, micaceous, finely sandy siltstone, containing common gypsum layers and occasional carbonaceous concretions | 113 |
| Gray to buff, fine-grained, silty, friable, massive sandstone, containing concretionary layers and abundant carbonaceous material | 72 |
| Gap | 10 |
| Gray, fine- to very fine-grained, friable, massive, micaceous, silty sandstone, containing common concretionary layers, silty layers, and fossil wood with abundant *Teredo* borings | 220 |
| Gray to buff-gray, firm, micaceous, finely sandy siltstone | 90 |
| | 1,120 |

**Chocolate-brown, massive, slightly silty, semi-platy, white-weathering Marca shale member of the Moreno, containing *Siphogenerinoides whitei* casts.**

# APPENDIX B
# FOSSIL REGISTERS

## MICROFOSSIL REGISTER [18]

### L. S. J. U. Loc. M-140 [19]

Fresno County, Panoche quadrangle, southeastern Panoche Hills, SE. corner NW¼ sec. 8, T. 15 S., R. 12 E., M.D., 2600 feet S. and 1900 feet E. of NW. corner sec. 8, T. 15 S., R. 12 E.

Escarpado Canyon is the first canyon north of Panoche Creek heading in the high ridge-forming Panoche formation, drains eastward into the valley, and cuts through the whole Moreno section.

*Formation.* Lodo, Cerros member.

*Stratigraphic position.* 180 feet stratigraphically above the top of glauconitic sand at base of Lodo. Locality is 260 feet stratigraphically above the brown shale of the Dos Palos.

Anomalina garzaensis
Cassidulina globosa
Cibicides martinezensis of Cushman and Siegfus (not of Cushman and Barksdale) pseudo-ungerianus
Dentalina approximata consobrina
obliquesuturata
Ellipsonodosaria annulifera
Epistomina eocenica
Eponides minimum umbonatus
sp.
Gaudryina coalingensis
Globigerina bulloides
Globorotalia aragonensis crassata
crassata densa
Gümbelina venezuelana
Gyroidina scrobiculata
Lagena isabella conscripta
Marginulinopsis subbullata
Nodosarella sp.
Nodosaria consobrina
Nonion wilcoxensis
Pseudoglandulina conica
Pseudouvigerina wilcoxensis
Pleurostomella nuttalli
Siphonina wilcoxensis
Vaginulinopsis alticostatus
sp.
and others

### L. S. J. U. Loc. M-145 [20]

Fresno County, Panoche quadrangle, locality given as middle of NW¼ sec. 13, T. 14 S., R. 11 E., M.D.

*Formation.* Morneo, Marca shale member.

*Collector.* S. P. Welles

Bulimina cf. B. prolixa
Valvulineria "pachecoensis"
and others

### L. S. J. U. Loc. M-151

Merced County, Charleston School quadrangle, Laguna Seca Creek drainage, 1600 feet W., 1900 feet N. of SE. corner sec. 14, T. 12 S., R. 10 E., M.D.

*Formation.* Panoche, Cretaceous.

*Collector.* H. G. Schenck and M. B. Payne, November, 1940.

**4860-70**

Bulimina cf. B. prolixa spinata
Eponides sp.
Nodosaria arundinea spinifera
Robulus sp.
Inoceramus prisms

**4870-80**

Bolivina incrassata
Bulimina prolixa spinata
Gyroidina globosa octocamerata
Nodosaria consobrina nuda spinifera
Robulus lepidus macrodiscus
Inoceramus prisms

**4880-90**

Bulimina spinata
Eponides
Guttulina trigonula
Gyroidina globosa
Nodosaria arundinea spinifera
Robulus lepidus macrodiscus
Inoceramus prisms

**4890-4900**

Bulimina spinata
Eponides sp.
Guttulina trigonula
Nodosaria sp.
Palmula cf. P. pilulifera
Robulus lepidus macrodiscus
Marginulina bullata
Robulus macrodiscus
Silicosigmoilina californica
Inoceramus prisms

**4900-4910**

Bulimina spinata
Cyclammina sp.
Guttulina trigonula

**4910-4920**

Bathysiphon sp.
Cyclammina sp.
Silicosigmoilina californica

NOTE: Sample A is 5000 feet stratigraphically below base of Kreyenhagen.

### L. S. J. U. Loc. M-152 [21]

Fresno County, Panoche quadrangle, about 2500 feet upstream from angle in "Right Angle Canyon", 1500 feet S., 2400 feet E. of NW. corner sec. 12, T. 15 S., R. 11 E., M.D.

*Formation.* Panoche, Cretaceous.

*Collector.* Max Payne, 1940.

Ammodiscus sp.
Bathysiphon sp.
Gaudryina sp.
Silicosigmoilina californica
"Spiroplectoides" clotho
Trochammina sp.

Right Angle Canyon section

**0-1**

Bathysiphon sp.
Cyclammina sp.
Haplophragmoides sp.
Silicosigmoilina californica

**1-2**

Bathysiphon sp.
Bulimina obtusa
Cyclammina sp.
Gyroidina sp.
Silicosigmoilina sp.

**2-3**

Bathysiphon sp.
Cyclammina sp.
Haplophragmoides sp.
Silicosigmoilina californica

**3-4**

Bathysiphon sp.
Cibicides sp.
Cyclammina sp.
Eponides umbonatus
Robulus navarroensis cf. loetterle
Stensiöina sp.

**6-7**

Cyclammina sp.
Gaudryina crassaformis Cushman and Campbell
Silicosigmoilina californica
Trochammina globigeriniformis

**8-9**

Bathysiphon sp.
Cyclammina sp.
Silicosigmoilina californica

**9-10**

Bulimina obtusa
Cibicides sp. a *
Discorbis allomorphinoides
Eponides spinea umbonatus
Gaudryina cf. G. crassaformis
Gyroidina depressa globosa von Hagenow
Haplophragmoides
Pleurostomella
Robulus cf. R. lepidus Cushman and Church macrodiscus
Nodosaria ewaldi spinifera
Nodosaria sp.
Silicosigmoilina californica

**10-11**

Ammodiscus sp.
Bulimina sp. obtusa
Cibicides sp. a *
Eponides cf. E. spinea
Gyroidina depressa cf. G. globosa
Haplophragmoides
Nodosaria alternata soluta
Robulus cf. R. lepidus macrodiscus
Silicosigmoilina californica

**11-12**

Ammodiscus sp.
Cibicides sp. a *
Cyclammina sp.
Dentalina sp.
Eponides umbonatus
Gyroidina depressa
Nodosaria spinifera
Robulus lepidus
Silicosigmoilina californica

[18] Check lists of Foraminifera made by H. G. Schenck and Lois T. Martin, Stanford University.

[19] Provisional identifications by Lois T. Martin. H. G. Schenck comments that M-140 contains the same Foraminifera as are in the lower type Lodo.

[20] University of California Locality A-2953.

[21] Identifications are provisional.

**13-14**

Bathysiphon sp.
Haplophragmoides sp.
Silicosigmoilina californica

**15-16**

Bathysiphon sp.
Haplophragmoides sp.
Silicosigmoilina californica

**16-17**

Ammodiscus sp.
Bathysiphon sp.
Cibicides sp.
Eponides sp.
Gyroidina sp.
Haplophragmoides sp.
Marginulina sp.
Silicosigmoilina californica
Stensiöina sp.
Inoceramus prisms

**17-18**

Bulimina obtusa (sharp pointed, ornamented with fine striae)
Cibicides sp. a *
Eponides cf. E. spinea
cf. E. umbonatus
Globotruncana arca
Gyroidina depressa
Marssonella oxycona
Nodosaria spinifera (fragment)
Robulus lepidus sp.
Silicosigmoilina californica
Stensiöina excolata

* Sp. a, about 18 chambers, narrow, limbate sutures, dorsal side with thickened umbilical coil.

NOTE: Composite sample.

### L. S. J. U. Loc. M-202A [22]

Merced County, Ortigalita quadrangle, Ortigalita Creek, 1750 feet W. and 350 feet N. of SE. corner sec. 29, T. 11 S., R. 10 E., M.D.

*Formation.* Panoche, Cretaceous.

*Stratigraphic Position.* About 2000 feet stratigraphically below top of Panoche formation and about 300 feet stratigraphically below sand that should be Bennison's B of his Quinto.

**30-35**

Bolivina incrassata Reuss of Cushman and Campbell
Bulimina inflata of Galloway and Morrey
quadrata Plummer of Cushman and Parker
spinata Cushman and Campbell
Ceratobulimina sp.
Dentalina cf. D. confluens Reuss of Cushman
lorneiana d'Orbigny of Cushman
megapolitana of Cushman and Jarvis
reussi Neuge of Sandidge
soluta Reuss of Plummer
Epistomina caracolla Roemer of Cushman and Church
Eponides sp.
cf. E. umbonatus Reuss
Frondicularia sp. of Cushman and Campbell
Globulina lacrima Reuss of Cushman
Guttulina trigonula Reuss of Cushman
Gyroidina globosa (von Hagenow)
nitida Reuss of Loetterle
Marginulina cf. M. bronni of Cushman and Campbell
bullata Reuss of Cushman and Campbell
striato-carinata Cushman and Campbell
Nodosaria cf. N. intercostata Reuss of Cushman
nuda Reuss of Cushman and Campbell
spinifera Cushman and Campbell
Palmula pilulifera Cushman and Campbell
Robulus cf. R. lepidus Reuss of Cushman and Church
cf. R. macrodiscus Reuss of Cushman and Jarvis
sp.
williamsoni Reuss of Cushman
Saracenaria cf. S. acutauricularis of White
Vaginulina simondsi (fragment)

[22] Preliminary identifications by L. T. Martin, March, 1941.

*Garzas Creek section*

Stanislaus County, Pacheco Pass quadrangle, Garzas Creek. Near center of SE¼ sec. 19, T. 8 S., R. 8 E.

*Formation.* Panoche, Cretaceous.

*Stratigraphic Position.* Probably well down in the Panoche.

**1-900**

Bolivina incrassata
Bulimina spinata
Cibicides sp.
Dentalina aff. D. approximata
Gaudryina sp.
Globotruncana arca
Gyroidina depressa?
globosa
Nonion sp.
Robulus sp.

**1-1400**

Bathysiphon sp.
Bolivina cf. B. decurrens ?
Bulimina spinata
Cibicides sp.
Dentalina sp. a *
Gyroidina depressa
Marginulina striatocarinata
Nodosaria alternata
Nodosaria (distinctly costate, smaller than N. latejugata)
Pullenia sp.
Robulus macrodiscus

Stanislaus County, Pacheco Pass quadrangle, Garzas Creek, 2500 feet N. and 900 feet W. of SE. cor. sec. 19, T. 8 S., R. 8 E.

*Formation.* Panoche, Cretaceous

*Stratigraphic Position.* Probably well dowu in Panoche.

**4**

Bulimina prolixa
Cibicides sp.
Robulus lepidus
Eponides sp.
Gyroidina octocamerata
Robulus lepidus
Siphogenerinoides clarki Cushman and Campbell

**5**

Bulimina prolixa
cf. B. spinata
Cibicides sp.

**13**

Anomalina, Cibicides } several species of each

* Sp. a, about 18 chambers, narrow, limbate sutures, dorsal side with thickened umbilical coil.

*Los Banos Creek section*

Merced County, Ortigalita quadrangle, Los Banos Creek, 2200 feet S. and 2150 feet W. of NE. corner sec. 12, T. 11 S., R. 9 E.

*Formation.* Panoche, Cretaceous.

*Stratigraphic Position.* Several hundred feet below top of Panoche.

**440-450**

Bulimina spinata (flood)
Dentalina sp.
Marginulina cf. M. bronni
Nodosaria cf. N. consobrina
spinifera
Robulus macrodiscus
Inoceramus prisms

**9-19 ("Mustang" X)**

Merced County, Ortigalita quadrangle, Los Banos Creek, 1600 feet N. and 1350 feet W. of SE. corner sec. 11, T. 11 S., R. 9 E.

*Formation.* Panoche, Cretaceous.

*Stratigraphic Position.* Well down in Panoche.

Bulimina quadrata
Cyclammina sp.
Eponides cf. E. heidingerii
Gaudryina sp.
Globotruncana arca
Reussella?
Robulus sp.
Silicosigmoilina californica
Stensiöina sp.
Ventilabrella ornatissima

## MEGAFOSSIL REGISTER

| Locality | County | Quadrangle | Section | Exact locality | Formation | Stratigraphic position | Age | Collector | Faunule |
|---|---|---|---|---|---|---|---|---|---|
| L.S.J.U. No. 375 | Fresno | Panoche | 19, T. 14 S., R. 12 E. | 450 ft. S., 50 ft. E. of NW corner of section | Domengine | Near top of sand member | Middle Eocene | M. Payne | Turritella buwaldana etc. |
| L.S.J.U. No. 454 | Fresno | Panoche | 17, T. 15 S., R. 12 E. | 1800 ft. S., 1650 ft. W. of NE corner of section | Lodo | Basal Lodo | Paleocene | | |
| L.S.J.U. No. 460 | Fresno | Panoche | 24, T. 14 S., R. 11 E. | 300 ft. S., 650 ft. W. of NE corner of section | Laguna Seca | Basal Laguna Seca, 300 ft. stratigraphically below Domengine | Paleocene | | |
| L. S. J. U. No. 2116 | Fresno | Panoche | 13, T. 14 S., R. 11 E. | SE¼ SE¼ sec. 13. | Domengine | Pebble reef | Middle Eocene | M. Payne | Amaurellina (Euspirocrommium) clarki (Stewart) det. M. Payne<br>Ficopsis remondii (Gabb)<br>Nemocardium linteum (Conrad) det. M. Keen<br>Turritella andersoni<br>Ectinochilus maeilentus det. R. T. White<br>Venericardia hornii (Gabb)<br>Conus sp.<br>Galeodea tuberculiformis Hanna det. H. G. Schenck |
| L. S. J. U. No. 2118 | Fresno | Panoche | 13, T. 14 S., R. 11 E. | 1800 ft. N., 15 ft. W. of No. 2116 | Domengine | Pebble reef | Middle Eocene | M. Payne | Turritella andersoni<br>Nemocardium linteum (Conrad) det. M. Keen |
| L. S. J. U. No. 2245 | Fresno | Panoche | 24, T. 14 S., R. 11 E. | 100 ft. S., 700 ft. W. of NE corner of section | Basal Laguna Seca | Basal sand of Laguna Seca | Paleocene | | |
| L. S. J. U. No. 2251 | Fresno | Panoche | 12, T. 15 S., R. 11 E. | 600 ft. S., 800 ft. W. of NE corner of section | Panoche | Top of concretionary sandstone | Cretaceous | R. C. Brown<br>S. W. Muller<br>H. G. Schenck<br>M. B. Payne | Cephalopoda<br>Baculites cf. B. fairbanksi Anderson det. R. C. Brown<br>Gastropoda<br>Perissitys breviostris (Gabb) det. M. Keen<br>Turritella chicoensis Gabb det. R. C. Brown<br>Pelecypoda<br>Brachidontes sp. (?)<br>Lucina eretacea Gabb (?)<br>Ostrea sp. (?)<br>Parallelodon (Nanonavis) cf. P. vancouverensis (Meek) det. R. C. Brown<br>Also some undetermined Bryozoa |
| L. S. J. U. No. 2252 | Fresno | Panoche | 12, T. 14 S., R. 11 E. | 800 ft. S., 1750 ft. E. of NW corner of section | "Temblor" | 1 ft. above local base | Early middle Eocene | H. G. Schenck<br>M. B. Payne | Cirripedia<br>Balanus concavus Bronn<br>Pelecypoda<br>Chione temblorensis (Anderson)<br>Chlamys andersoni (Arnold)<br>Gastropoda<br>Turritella ocoyana Conrad det. and notes by M. Keen and H. G. Schenck |
| L. S. J. U. No. 2253 | Merced | Panoche | 18, T. 12 S., R. 11 E. | 1600 ft. N., 2200 ft. E. of SW corner of section | Laguna Seca | 350 ft. above base | Paleocene | H. G. Schenck<br>M. B. Payne | Turritella pachecoensis and associated fauna |
| L. S. J. U. No. 2254 | Fresno | Panoche | 19, T. 14 S., R. 12 E. | 2000 ft. N., 500 ft. E. of SW corner of section | Domengine | 85 ft. above base of Domengine | Middle Eocene | H. G. Schenck<br>M. B. Payne | Turritella buwaldana etc. |
| L. S. J. U. No. 2290 | Fresno | Panoche | 8, T. 15 S., R. 12 E. | 1100 ft. E., 2700 ft. S. of NW corner of section | Lodo | Basal Lodo or Cerros sand | Paleocene | H. G. Schenck<br>M. B. Payne<br>Nov. 1940 | Large Echini<br>Gastropods<br>Pelecypods |
| L. S. J. U. No. 2292 | Fresno | Panoche | 8, T. 15 S., R. 12 E. | 2700 ft. S., 800 ft. E. of NW corner of section | Moreno | Cima sand lentil | Paleocene | S. W. Muller<br>H. G. Schenck<br>R. C. Brown<br>M. B. Payne | Tornatellaea sp. similar to T. pinguis det. S. W. Muller |
| L. S. J. U. No. 2293 | Fresno | Panoche | 8, T. 15 S., R. 12 E. | 2600 ft. S., 600 ft. E. of NW corner of section | Moreno | Near top of lower Dos Palos shale and just below Cima sand lentil | Paleocene | S. W. Muller<br>H. G. Schenck<br>R. C. Brown<br>M. B. Payne | ?Lucina eretacea Gabb<br>Tornatellaea sp. |

## MEGAFOSSIL REGISTER—Continued

| Locality | County | Quadrangle | Section | Exact locality | Formation | Stratigraphic position | Age | Collector | Faunule |
|---|---|---|---|---|---|---|---|---|---|
| L. S. J. U. No. 2311 | Fresno | Panoche | 19, T. 14 S., R. 12 E. | 2100 ft. S., 600 600 ft. E. of NW corner of section | Domengine Capita shale | 55 ft. above upper fossil reef of Domengine and 400 ft. below Kreyenhagen shale | Middle Eocene | S. W. Muller<br>H. G. Schenck<br>R. C. Brown<br>M. B. Payne | Exputens alexi etc.<br>Abundant foraminifera |
| L. S. J. U. No. 2320 | Merced | Panoche | 19, T. 11 S., R. 10 E. | 1700 ft. S., 400 ft. W. of NE corner of section | Panoche | 1000 ft. below top of Panoche | Upper Cretaceous | | |
| L. S. J. U. No. 2321 | Fresno | Panoche | 30, T. 14 S., R. 12 E. | 1700 ft. S., 1350 ft. E. of NW corner of section | Domengine | Middle of 100 ft. of Domengine sand | Middle Miocene | M. B. Payne | Turritella buwaldana etc. |
| L. S. J. U. No. 2322 | Fresno | Panoche | 30, T. 14 S., R. 12 E. | 1650 ft. N. 2000 ft. E. of SW corner of section | Domengine | Upper reef of Domengine sand near top of sand member | Middle Eocene | M. B. Payne | Turritella buwaldana etc. |
| L. S. J. U. No. 2341 | Merced | Panoche | 28, T. 11 S., R. 12 E. | 2500 ft. S., 1400 ft. E. of NW corner of section | Panoche | At base of sand unit at top of of Panoche | Upper Cretaceous | | |
| L. S. J. U. No. 2372 | Merced | Charleston School | 12, T. 12 S., R. 10 E. | 1200 ft. N., 1650 ft. E. of SW corner of section | Moreno | At top of Mercy sand lentil | Upper Cretaceous | R. C. Brown<br>Gary Ellis<br>Ivan Wilson<br>H. G. Schenck<br>M. B. Payne | Acila (Truncacila) princeps described by H. G. Schenck, type locality |
| L. S. J. U. No. 2382 | Merced | Charleston School | 33, T. 11 S., R. 10 E. | 3150 ft. N., 400 ft. W. of SE corner of section | Panoche | Top of Panoche | Upper Cretaceous | M. B. Payne | Glycymeris veatchii (Gabb)<br>Acila sp. indet.<br>Hamites sp.<br>Tenea inflata Gabb |

Dr. Hubert Lyman Clark examined a fossil fragment from L. S. J. U. Locality No. 2290 and reported that it resembled *Linthia* or *Brissus*, possibly *Brissus kewi* G. and H., but better material is needed for an identification.

Dr. Bruce L. Clark identified a specimen from this same locality L. S. J. U. No. 2290 as *Cophocara* but not the same species as *Cophocara stantoni* Stewart which was from the "Cretaceous".

C. C. Church and G. D. Hanna collected in the Panoche Hills at the Cal. Acad. Sci. Loc. 37318, *Flabellum remondianum* Gabb, "*Neptunea*" *cretacea* (Gabb), *Brachysphingus sinuatus* Gabb, "*Lucina*" n. sp., *Acila* sp., *Dentalium*.

By letter H. G. Schenck stated that these fossils probably came from the Cima sand below the glauconitic shale at the base of the Lodo formation.

John W. Wells commented on *Flabellum* sent him by H. G. Schenck from Jergins Chaney Ranch Well No. 1 (5800 ft.) and said it may be part of *F. californicum* (Vaughan), an Eocene species, or part of *F. remondianum* Gabb, Eocene. Schenck (written communication) states that he believes *F. remondianum* indicates Paleocene age, and that the genus *Flabellum* is not known in the Cretaceous.

## VERTEBRATE REGISTER

| Locality | County | Quadrangle | Section | Exact locality | Formation | Stratigraphic position | Age | Faunule |
|---|---|---|---|---|---|---|---|---|
| C.I.T. No. 328 | Fresno | Panoche | 36, T. 14 S., R. 11 E. | 800 ft. S., 300 ft. W. of NE corner of section. | Moreno | 140 ft. below Marca shale | Upper Cretaceous | Mosasaur |
| C.I.T. No. 331 | Fresno | Panoche | 36, T. 14 S., R. 11 E. | 900 ft. S., 400 ft. E. of NE corner of section. | Moreno | 175 ft. below Marca shale | Upper Cretaceous | |
| C.I.T. No. 336 | Fresno | Panoche | 36, T. 14 S., R. 11 E. | 800 ft. S., 1050 ft. W. of NE corner of section. | Moreno | 425 ft. below Marca shale | Upper Cretaceous | Trachodon |
| C.I.T. No. 337 | Fresno | Panoche | 25, T. 14 S., R. 11 E. | 2500 ft. S., 850 ft. W. of NE corner of section. | Moreno | 10 ft. below Marca shale | Upper Cretaceous | Plesiosaur |
| C.I.T. No. 338 | Fresno | Panoche | 13, T. 14 S., R. 11 E. | 1000 ft. S., 650 ft. E. of NW corner of section. | Moreno | 135 ft. below Marca shale | Upper Cretaceous | Saurian? Plesiosaur |
| C.I.T. No. 339 | Fresno | Panoche | 36, T. 14 S., R. 11 E. | 1000 ft. S., 750 ft. W. of NE corner of section. | Moreno | 390 ft. below Marca shale | Upper Cretaceous | Saurian? |
| C.I.T. No. 340 | Fresno | Panoche | 31, T. 14 S., R. 12 E. | 1800 ft. S., 50 ft. E. of NW corner of section. | Moreno | 20 ft. above base of Marca shale. | Upper Cretaceous | Plesiosaur |
| C.I.T. No. 347 | Fresno | Panoche | 11, T. 14 S., R. 11 E. | 500 ft. S., 2400 ft. W. of NE corner of section. | Moreno | 680 ft. below Marca shale | Upper Cretaceous | Saurian tail |
| C.I.T. No. 354 | Fresno | Panoche | 11, T. 14 S., R. 11 E. | 110 ft. S., 2400 ft. W. of NE corner of section. | Moreno | 550 ft. below Marca shale | Upper Cretaceous | Plesiosaur |
| C.I.T. No. 357 | Fresno | Panoche | 21, T. 16 S., R. 12 E. | 1200 ft. S., 400 ft. E. of NW corner of section. | Moreno | Several hundred ft. below Mercy sand. | Upper Cretaceous | Trachodon |

## VERTEBRATE REGISTER—Continued

| Locality | County | Quadrangle | Section | Exact locality | Formation | Stratigraphic position | Age | Faunule |
|---|---|---|---|---|---|---|---|---|
| C.I.T. No. 380 | Fresno | Panoche | 5, T. 16 S., R. 12 E. | 700 ft. N., 100 ft. W. of SE corner of section. | Moreno | 40 ft. above Marca shale | Upper Cretaceous | Mosasaur |
| C.I.T. No. Field Loc. "IL" | Fresno | Panoche | 13, T. 14 S., R. 11 E. | 1000 ft. E., 900 ft. S. of NW corner of section. | Moreno | 25 ft. below Marca shale | Upper Cretaceous | |
| U.C. No. V3735 | Fresno | Panoche | 13, T. 14 S., R. 11 E. | 1050 ft. S., 900 ft. E. of NW corner of section. | Moreno | 75 ft. below Marca shale | Upper Cretaceous | Mosasaur |

## FOSSIL LOCALITIES

| County | Quadrangle | Section | Exact locality | Formation | Stratigraphic position | Age | Collector | Faunule |
|---|---|---|---|---|---|---|---|---|
| Fresno | Panoche | 21, T. 15 S., R. 12 E. | 2450 ft. S., 2450 ft. E. of NW corner of section. | Domengine | Top of Capita shale | Middle Eocene | H. G. Schenck | Foraminifera |
| Merced | Ortigalita | 28, T. 11 S., R. 10 E. | 1450 ft. E., 2550 ft. S. of NW corner of section. | Panoche | 290 ft. below top of Panoche | Upper Cretaceous | M. B. Payne | Megafossil |
| Merced | Ortigalita | 11, T. 11 S., R. 9 E. | 1650 ft. N., 1400 ft. W. of SE corner of section. | Panoche | | Upper Cretaceous | M. B. Payne | Foraminifera |
| Merced | Ortigalita | 12, T. 11 S., R. 9 E. | 900 ft. W., 2350 ft. S. of NE corner of section. | Panoche | | Upper Cretaceous | M. B. Payne | Megafossil |
| Merced | Ortigalita | 12, T. 11 S., R. 9 E. | 2250 ft. S., 2150 ft. W. of NE corner of section. | Panoche | | Upper Cretaceous | M. B. Payne | Nodosaria, Spinifera, Inoceramus prisms |
| Merced | Volta | 35, T. 10 S., R. 9 E. | 225 ft. S., 750 ft. W. of NE corner of section. | "Garzas" float? | | ? | H. G. Schenck M. B. Payne | Megafossil |
| Merced | Volta | 27, T. 10 S., R. 9 E. | 200 ft. W., 800 ft. N. of SE corner of section. | "Volta" float? | | Cretaceous | H. G. Schenck | Megafossils |
| Merced | Volta | 26, T. 10 S., R. 9 E. | 1900 ft. S., 475 ft. E. of NW corner of section. | Panoche | | Cretaceous | M. B. Payne | Megafossils, Ostrea sp. |
| Merced | San Luis Creek | 25, T. 10 S., R. 8 E. | 1550 ft. S., 220 ft. W. of NE corner of section. | Panoche | | Cretaceous | M. B. Payne | Megafossils |
| Merced | Howard Ranch | 14, T. 9 S., R. 8 E. | 2400 ft. S., 50 ft. E. of NW corner of section. | "Quinto" silt | Sand reef near middle of Quinto | Cretaceous | M. B. Payne | Ostrea sp., Fossil fragments |
| Merced | Charleston School | 13, T. 12 S., R. 10 E. | 1600 ft. S., 350 ft. W. of NE corner of section. | Moreno | 50 ft. above top of Panoche | Upper Cretaceous | M. B. Payne | Megafossils |
| Merced | Charleston School | 13, T. 12 S., R. 10 E. | 850 ft. S., 600 ft. W. of NE corner of section. | Panoche | 50 ft. below top of Panoche | Upper Cretaceous | H. G. Schenck M. B. Payne | Siphogenerinoides whitei |
| Merced | Charleston School | 13, T. 12 S., R. 10 E. | 1600 ft. N., 1750 ft. E. of SW corner of section. | Panoche | 350 ft. below top of Panoche | Upper Cretaceous | H. G. Schenck M. B. Payne | Siphogenerinoides clarki var. |
| Merced | Charleston School | 13, T. 12 S., R. 10 E. | 2100 ft. S., 850 ft. E. of NW corner of section. | Panoche | Top concretionary reef of the Panoche | Upper Cretaceous | M. B. Payne | Megafossils |
| Merced | Charleston School | 14, T. 12 S., R. 10 E. | 1600 ft. N., 1100 ft. W. of SE corner of section. | Panoche | 4860 ft. below top of Panoche | Upper Cretaceous | M. B. Payne | Nodosaria spinifera Inoceramus prisms |
| Merced | Charleston School | 11, T. 12 S., R. 10 E. | 2000 ft. S., 1300 ft. W. of NE corner of section. | Moreno | 450 ft. above top of Panoche | Upper Cretaceous | M. B. Payne | Megafossils |
| Merced | Charleston School | 11, T. 12 S., R. 10 E. | 2500 ft. S., 2500 ft. W. of NE corner of section. | Panoche | Top of Panoche reef | Upper Cretaceous | M. B. Payne | Megafossils |
| Merced | Charleston School | 1, T. 12 S., R. 10 E. | 100 ft. N., 1050 ft. E. of SW corner of section. | Laguna Seca | 100 ft. below top | Paleocene | M. B. Payne | Megafossils |
| Merced | Charleston School | 1, T. 12 S., R. 10 E. | 700 ft. N., 400 ft. E. of SW corner of section. | Laguna Seca | 50 ft. below top | Paleocene | M. B. Payne | Megafossils |
| Fresno | Panoche | 5, T. 15 S., R. 12 E. | 1900 ft. N., 100 ft. E. of SW corner of section. | Domengine | Middle of sand | Middle Eocene | H. G. Schenck M. B. Payne | Megafossils |

41152 3-51 2M

GARZAS CREEK TO SEABOARD HOWARD NO. 1
LAGUNA SECA CREEK TO BERGMAN PET.-ORA LOMA FARMS NO. 1
CHANEY RANCH CANYON TO RICHFIELD STONE-BRAGG NO. 1
ESCARPADO CANYON TO JERGINS-CHANEY RANCH NO. 1
LEGEND
QUAT
RECENT
TERTIARY
MIOCENE
EOCENE
PALEOCENE
CRETACEOUS
UPPER CRETACEOUS
Qal ALLUVIUM & STREAM GRAVELS
Qt & Qls TERRACE DEPOSITS & LANDSLIDE DEBRIS
Mi MIOCENE CLAYSTONE & MUDSTONE NON-MARINE (TEMBLOR)
Ek KREYENHAGEN SHALE FORMATION
Ecr CHANEY RANCH SAND FORMATION
Ed-c CAPITA SHALE MEMBER
Ed-n NONADA SAND MEMBER
DOMENGINE FORMATION
HONDO SHALE MEMBER
CANTUA SANDSTONE MEMBER
El-c CERROS SHALE MEMBER
BASAL CERROS SS. MEMBER
LODO FORMATION OF R.T. WHITE
Els LAGUNA SECA SANDSTONE FORMATION OF THIS REPORT
Km-dp DOS PALOS SHALE MEMBER
Km-c CIMA SAND LENTIL
Km-dp DOS PALOS SHALE MEMBER
Km-m MARCA SHALE MEMBER
Km-t TIERRA LOMA SHALE MEMBER
Km-me MERCY SAND LENTIL
Km-t TIERRA LOMA SHALE MEMBER
Km-d DOSADOS SS & SH MEMBER
MORENO FORMATION OF THIS REPORT
Kp PANOCHE FORMATION
GEOLOGIC MAP OF THE TYPE MORENO FORMATION (UPPER CRETACEOUS) AND OVERLYING EOCENE STRATA (TERTIARY) ON THE WEST SIDE OF THE SAN JOAQUIN VALLEY, FRESNO AND MERCED COUNTIES, CALIFORNIA
M.B. PAYNE 1941
SCALE OF MILES
0 1 2 3 4 5
AIR PHOTO AND U.S.G.S. TOPO BASE MAPS
ROMERO SCHOOL
VOLTA
TRENT
SOUTHERN PACIFIC RAILROAD
TO LOS BANOS
TO GILROY
SAN LUIS
BASALT HILL 1705
MUSTANG CREEK
QUINTO CREEK
SAN LUIS CREEK
LOS BANOS CREEK
SALT CREEK
ORTIGALITA CREEK
LAGUNA SECA CREEK
LITTLE PANOCHE CREEK
PANOCHE DE SAN JUAN
LOS CARRISALITOS
MERCED
FRESNO
SAN BENITO
STANISLAUS
ESCARPADO CANYON
DOSADOS CANYON
CAPITA CANYON
CHANEY RANCH CANYON
MARCA CANYON
RIGHT ANGLE CANYON
TUMEY GULCH
TUMEY HILLS
CERROS HILL
MORENO GULCH

# COMPARATIVE LITHOLOGIC COLUMNAR SECTIONS

- SE -

- NW -

VERTICAL SCALE
OUTCROP SECTIONS
0 500' 1000' 2000' 3000' 4000' 5000'
NO HORIZONTAL SCALE

Datum *Siphogenerinoides whitei* Zone

LEVIS or "CUP" CANYON
Sec. 16, T.16S., R.13E.

5 MILES SOUTH OF PANOCHE-SILVER CREEK JUNCTION AND EAST THRU TUMEY GULCH
Sec. 1, 11, 15, 16, T.16S., R.12E.

3 MILES SOUTH OF PANOCHE-SILVER CREEK JUNCTION
Sec. 9, 3, 2, T.16S., R.12E.

ESCARPADO CANYON
Sec. 7, 8, T.15S., R.12E.

CHANEY RANCH CANYON
Sec. 19, T.14S., R.12E.

GRES CANYON
Sec. 12, T.14S., R.11E.

MORENO GULCH
Sec. 1, 11, T.14S., R.11E.

2 MILES NORTH OF LITTLE PANOCHE CREEK
Sec. 4, 5, 8, T. 13S., R.11E.

LAGUNA SECA
Sec. 18, T.12S., R.11E.
Sec. 13, 14, 23, 20, T.12S., R.10E.

ORTIGALITA CREEK
Sec. 28, 29, 32, 31, T.11S., R.10E.

LOS BANOS CREEK
Sec 6, T.11S., R.10E.
Sec. 12, 13, T.11S., R.9E.

QUINTO CREEK
Sec. 11, 15, T.9S., R.8E.

GARZAS CREEK
Sec. 20, 29, T.8S., R.8E.

NOTE: N.L. Taliaferro reports Lower Cretaceous (Horsetown) in Quinto Cr., overlain by Pacheco Group (7000-8000'), yet considers QUINTO and MUSTANG members equivalent to type MORENO w/ GARZAS Sand youngest of all. Quinto Cr. conglomerate reported to have Turonian fossils, thus Asuncion and Pacheco terms are ambiguous, at least in part.

C. Stock puts vertebrates found in TIERRA LOMA Shale and basal MARCA Shale in Maestrichtian and would probably place 003 PALOS Shale in Danian.

F.M. Anderson considers MORENO = to Danian, Maestrichtian but includes QUINTO (incl. MUSTANG) and GARZAS (incl. VOLTA) as equivalent to MORENO and lists fossils therefrom as equivalent to MORENO.

STANDARD of the CRETACEOUS SYSTEM (Siemon Wm. Muller & Hubert G. Schenck (1941)) | N.L. Taliaferro (1941)

| Series | Stages and Substages | Zonation by Ammonites | Zonation by Foraminifera | Provisional dating of California formations | Formations | Group |
|---|---|---|---|---|---|---|
| Upper Cretaceous — Senonian | Danian | *Hercoglossa danica* | | Upper 005 PALOS | GARZAS Sandstone | |
| | Maestrichtian | *Scaphites constrictus* | *Globotruncana conica* | "Pachydiscus Silt" CHICO | MORENO and PANOCHE | Asuncion |
| | Campanian | *Bostrychoceras polyplocum*<br>*Dechenoceras coesfeldiense*<br>*Submortoniceras delawarense*<br>*Placenticeras bidorsatum* | *Globotruncana arca* | | | |
| | Santonian | *Placenticeras syrtale*<br>*Placenticeras clypeale* | | | | |
| | Coniacian | *Barroisiceras haberfellneri* | > *Globotruncana linneiana* | | | |
| | Turonian | *Pseudojacobites formeryi*<br>*Prionocyclus neptuni*<br>*Hammites nodosoides* | | | Congl. in Quinto Cr. | Pacheco |
| | Cenomonian | *Fagesia superstes*<br>*Metoicoceras pantieri*<br>*Acanthoceras rhotomagense*<br>*Schloenbachia varians* | | | | |
| Lower Cretaceous | Albian | *Mantelliceras martimpreyi*<br>*Stoliczkaia dispar*<br>*Mortoniceras inflatum* | | | | |

## RIGHT ANGLE CANYON - SAMPLE UP-SECTION

0-1 Bathysiphon, Cyclammina or Heplophragmoides, Silicasigmoilina californica
1-2 Bathysiphon, Silicasigmoilina, Cyclammina, Bulimina obtusa, Gyroidina
2-3 Bathysiphon, Silicasigmoilina californica, Cyclammina or Haplophragmoides
3-4 Bathysiphon, Cibicides, Eponides umbonatus, Rabulus navarroensis cf Loetterle, Stensioina, Cyclammina
4-7 Cyclammina, Silicasigmoilina californica, ~~Gaudryina crassaformis, Cushman and Campbell~~, Trochammina globigeriniformis
8-9 Cyclammina, Silicasigmoilina californica, Bathysiphon
9-10 Bulimina obtusa, Silicasigmoilina californica, Haplophragmoides, Cibicides Sp.'a', Nodosaria spinifera, N. ewaldi, Eponides umbonatus, Pleurostomella, Rabulus macrodiscus, Eponides spinea, Gyroidina globosa var. Hagenow, Gaudryina cf. crassaformis, Gyroidina depressa, Discorbis allamorphinoides, Rabulus lepidus cf Cushman and Church
10-11 Bulimina obtusa, Cibicides Sp.'a', Haplophragmoides, Silicasigmoilina calif., Nodosaria alternata, Rabulus macrodiscus, Ammodiscus, Nodosaria soluta, Bulimina, Eponides spinea, Gyroidina depressa, G. cf. globosa, Rabulus cf. lepidus
11-12 Silicasigmoilina californica, Cyclammina, Eponides umbonatus, Cibicides Sp.'a', Ammodiscus, Nodosaria spinifera, Rabulus lepidus, Gyroidina depressa, Dentalina
13-14 Silicasigmoilina californica, Haplophragmoides, Bathysiphon
15-16 Haplophragmoides, Silicasigmoilina californica, Bathysiphon
16-17 Bathysiphon, Silicasigmoilina californica, Ammodiscus, Haplophragmoides, Stensioina, Eponides, Marginulina, Gyroidina, Cibicides, Inoceramus prisms
17-18 Bulimina obtusa, B. sp., Cibicides Sp.'a', Stensioina excolata, Gyroidina depressa, Marssonella oxycona, Eponides cf. spinea, E. cf. umbonatus, Globotruncana arca, Rabulus lepidus, R. sp., Silicasigmoilina californica, Nodosaria spinifera (frag.), Inoceramus prisms

## LAGUNA SECA SAMPLE DOWN-SECTION

4860-70' Nodosaria spinifera, Rabulus, Bulimina cf. prolixa, Eponides, Bulimina spinata, Nodosaria arundinea, Inoceramus prisms
4870-80' Nodosaria spinifera, Bulimina spinata, Rabulus lepidus, Bolivina incrassata, Rabulus macrodiscus, Gyroidina octocamerata, G. globosa, Nodosaria consobrina, Bulimina prolixa, Nodosaria nuda, Inoceramus prisms
4880-90' Bulimina spinata, Rabulus lepidus, Eponides, Guttulina trigonula, Rabulus macrodiscus, Gyroidina globosa, Nodosaria arundinea, N. spinifera, Inoceramus prisms
4890-4900' Bulimina spinata, Rabulus macrodiscus, Rabulus lepidus, cf. Palmula pilulifera, Guttulina trigonula, Eponides, Nodosaria
4900-10' Cyclammina, Guttulina trigonula, Marginulina bullata, Rabulus macrodiscus, Bulimina spinata, Silicasigmoilina colif., Inoceramus prisms
4910-20' Silicasigmoilina calif., Bathysiphon, Cyclammina

## ORTIGALITA CR. SEC.

30-35 Bolivina incrassata Reuss, Bulimina quadrata Plummer, B. inflata, B. spinata, Ceratobulimina sp., Dentalina laziana d'Orb., D. mexpolitana, D. reussi, D. soluta, D. cf. confluens, Epistomina carocalla, Eponides sp., E. cf. umbonatus, Globulina lactima, Gyroidina globosa, G. nitida, Marginulina cf. branni, M. striato-carinata, Nodosaria nuda, N. spinifera, N. cf. intercostata, Palmula pilulifera, Marginulina bullata, Rabulus williamsoni, R. cf. lepidus, R. cf. macrodiscus, R. macradiscus, Saracenaria cf. acutauricularis, Frondicularia sp., Inoceramus prisms

Marginulina jonesi reported near base of sand in Laguna Seca Creek Section

## LOS BANOS CR.

440-450 Inoceramus prisms, Bulimina spinata, Dentalina, Rabulus macrodiscus, Marginulina cf. branni, Nodosaria cf. consobrina, M. spinifera

## LOS BANOS MUSTANG X

9-10 Globotruncana arca, Rabulus, Cyclammina, Gaudryina, Eponides cf. haidingerii, Ventilabrella ornatissima, Reussella? Bulimina quadrata, Silicasig. calif. Stensioina

## SOUTH SIDE SAN LUIS CREEK
Sec. 20, T. 10S., R. 9E.

## ROMERO CREEK
Sec. 23, T. 9S., R. 8E.

## GARZAS CR. SEC.

5 Bulimina prolixa, Cibicides, Siphogenerinoides clarki, Cushman & Campbell, Gyroidina octocamerata, Eponides, Rabulus lepidus, Bulimina cf. spinata
4 Bulimina prolixa, Rabulus lepidus, Cibicides

1-900 Gyroidina globosa, Nonion, Dentalina approximata-like, Cibicides, Rabulus, Bulimina spinata, Bolivina incrassata, Gaudryina, Gyroidina depressa?, Globotruncana arca
1-1400 Bulimina spinata, Marginulina striatocarinata, Gyroidina depressa, Rabulus macrodiscus, Pullenia, Bathysiphon, Nodosaria alternata, Cibicides, Bolivina cf. decurrens?, Dentalina, Nodosaria (costate)

Isolated "Type VOLTA" boulder may be float
Brown shale in Los Banos Cr. bed - probably TIERRA LOMA
Fossiliferous atc., GARZAS of some workers but actually much higher in section than Type GARZAS Sand of Garzas Cr. in Columnar section #1

Glycymeris reef - called middle or "QUINTO B" of QUINTO in Garzas Creek

"QUINTO A" compare with Columnar Sec. 1&2

"MUSTANG"

Marginulina jonesi * reported here

Sand facies of QUINTO & MUSTANG of Garzas Cr. sec.

Eocene transgression

QUINTO Silt

Arbitrary division

MUSTANG Shale

Siphogenerinoides clarki

* Marginulina jonesi

Top Cret. of this area T. chaneyi, Parapachidiscus, Ammonites, Mosasaur skulls

VOLTA Sand - indistinct division of GARZAS GARZAS Sand - Type section

Broken line indicates Top of PANOCHE Formation of Anderson and Pack (1915), F.M. Anderson (1938) ? ch. date, A.P. Bennison (1939-41), A.R. Huey (1941) and of N.L. Taliaferro (1941)
NOTE: This line crosses lithologic and fossil time lines

* Marginulina jonesi, by usage, designates a group or an assemblage of several Marginulina and other foraminifera.

Eocene transgression

May be Top PANOCHE fm. or fossiliferous sd. facies of TIERRA LOMA Shale

Eocene transgression

White, pink strkd. anuxitic sand - probably Eocene

Basal Tk

15' Anouxitic sand probably CHANEY RANCH Sand - not shown

Basal CERROS sd.

disconformity

disconformity

Siphogenerinoides whitei

Arenaceous faunule
Globotruncana arca
Siphogenerinoides clarki var.

Siphogenerinoides clarki var. w/ Globotruncana arca

1st Inoceramus prism flood

Siphogenerinoides clarki
Marginulina sp. (small)

* Marginulina jonesi

* Marginulina jonesi probably ranges down thru this thick unit and possibly into green-gray shales below conglomerate

Black-weathering sd. of type sec. in Panoche Hills - approx. equivalent to Ortigalita congl. at right

8000 - 10,000 Ft. of greenish gray silty shale with thin limestone reefs, occas. sds. and more sandy to the north

Conglomerate traced as far south as Salt Canyon which drains into Little Panoche Cr.

Ortigalita Cr. conglomerate traced northward as far as Ramera Cr.

Turritella chicoensis
Acila (Truncacila) demessa
Parallelodon (Nanonavis) cf. vancouverensis
Baculites cf. fairbanksi
Hamites ellipticus
This fauna found in Type CHICO

## TENTATIVE CHECK LIST OF RANGES

| Formation | Lithologic Unit | Valvulineria "panochensis" | Pelecyne-like megafauna | Valvulineria "pachecoensis" | Siphogenerinoides whitei | Siphogenerinoides clarki var. | Siphogenerinoides clarki | Bulimina prolixa | Globotruncana conica | Globotruncana arca | * Marginulina jonesi | Silicasigmoilina californica | Inoceramus prisms | Nodosaria spinifera | Turritella chicoensis fauna |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PANOCHE | Upper 5000' | | | | | | | | | | | | | | |
| | Middle 4000 | | | | | | | | | | | | | | |
| | L. 8000 - 10,000' | | | | | | | | | | | | | | |
| MORENO | DOS PALOS | Upper 003 | | | | | | | | | | | | | |
| | CIMA Sand | | | | | | | | | | | | | | |
| | Lower 005 PALOS Sh. | | | | | | | | | | | | | | |
| | MARCA Shale | | | | | | | | | | | | | | |
| | TIERRA LOMA Sh. | | | | | | | | | | | | | | |
| | DOS AMOS | | | | | | | | | | | | | | |

* Marginulina jonesi

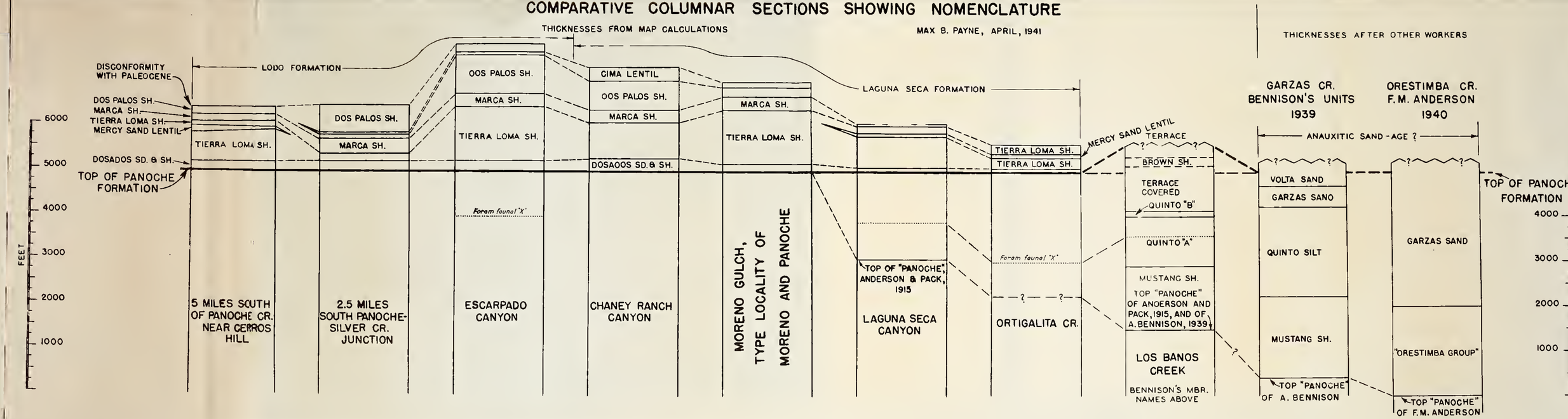
OLAF P. JENKINS, CHIEF
STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES
SPECIAL REPORT NO. 9
PLATE 3

# COMPARATIVE COLUMNAR SECTIONS SHOWING NOMENCLATURE

THICKNESSES FROM MAP CALCULATIONS

MAX B. PAYNE, APRIL, 1941

THICKNESSES AFTER OTHER WORKERS



# COLUMNAR SECTIONS OF THE EOCENE AND UPPERMOST CRETACEOUS SEDIMENTS IN THE PANOCHE AND LAGUNA SECA HILLS

PANOCHE HILLS | LAGUNA SECA HILLS

VERTICAL SCALE
0 100' 200' 300' 400' 500'
HORIZONTAL SCALE NONE — SEE MAP

## ESCARPADO CANYON
SECTION 7&8, T15S, R12E

20'-50' TEMBLOR MIOCENE
UNCONFORMITY

700' KREYENHAGEN SHALE FORMATION

35'
50' CAPITA SHALE
60' NONADA SAND
UNCONFORMITY

420' LOOO FORMATION
(CERROS FORAMINIFERA)

DISCONFORMITY

80' BASAL LOOO SO-80' GLAUC SO W PALEOCENE MEGAFOSSILS
TUR PACHECOENSIS FOUND SOUTH-SIDE PANOCHE CREEK
AT OR NEAR THIS HORIZON IN GRAY SAND
DISCONFORMITY

180' DOS PALOS SHALE WITH ABUN GLAUC
"GREEN BUG" AREN FAUNULE

90' CIMA SAND
PALEOCENE MEGAFOSSILS FOUND AT LEAST AS LOW AS BASE OF CIMA SAND

X VALVULINERIA LILLISI

600' DOS PALOS SHALE

ABUNDANT SIPHOGENERINOIDES WHITEI

MARCA SHALE

## CHANEY RANCH CANYON
SECTION 19, T14S, R12E

TERRACE

220' KREYENHAGEN
"SALT & PEPPER" SAND OF KREYENHAGEN
GLAUCONITE AT BASE

234' CHANEY RANCH SAND

30' CAPITA SHALE

70' NONADA SAND
UNCONFORMITY

300' LAGUNA SECA SANOSTONE

DISCONFORMITY

350' CIMA SAND

DOS PALOS SHALE

400'

MARCA SHALE

## GRES CANYON
SECTION 12, T14S, R11E

25' CHANEY RANCH SAND
60' CAPITA SHALE
30' NONADA SAND
UNCONFORMITY

200' LAGUNA SECA SANOSTONE

DISCONFORMITY

70'

380' DOS PALOS SHALE

280' MARCA SHALE

## LAGUNA SECA CREEK
SECTION 18, T12S, R11E.
SECTION 13,14,20,23, T12S, R10E.

100' TEMBLOR ?
UNCONFORMITY

700' KREYENHAGEN SHALE FORMATION

KREYENHAGEN SAND

WHITE ANAUXITIC SAND OF CHANEY RANCH ?

200' DOMENGINE ?
NO PEBBLE REEFS
NO FOSSILS FOUND

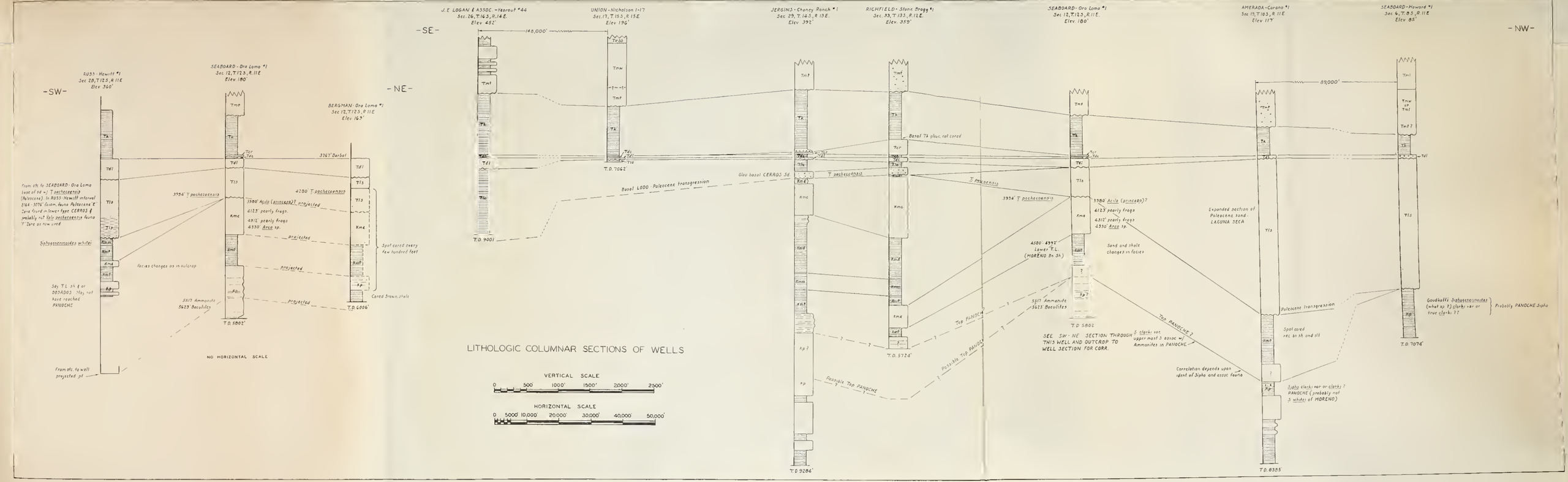
UNCONFORMITY

1100' LAGUNA SECA SANOSTONE

TURRITELLA PACHECOENSIS & OTHER PALEOCENE MEGAFOSSILS

ABUNDANT SIPHOGENERINOIDES WHITEI

30-40' MARCA OR TIERRA LOMA SHALE


-SW-
-NE-
-SE-
-NW-
RUSS - Hewitt #1
Sec 28, T12S, R 11E
Elev 360'
SEABOARD - Oro Loma #1
Sec 12, T12S, R. 11E
Elev. 180'
BERGMAN - Oro Loma #1
Sec 12, T12S, R 11E
Elev 163'
From dtc. to SEABOARD - Oro Loma base of 36 m.) T. pachyceanis (fulsoceae). In RUSS - Hewitt interval 2164 - 3076' Eocen. fauna Paleocene 'E' Zone found in lower type CERROS & probably not Velo pachyceanis fauna 'F' Zone as now used
3994' T. pachyceanis
4280 T. pachyceanis
3760' Barbat.
3980' Acila (grinnelli)? projected
4123' pearly fragg.
4312' pearly fragg.
4330' Arca sp.
projected
Siphogenerinoides whitei
facies changes as in outcrop
projected
Spot cored every few hundred feet
Sdy. T.L. 35 ft or DOSADOS clay not have reached PANOCHE
5617 Ammonite
5623' Baculites
projected
Cored Brown shale
From dtc. to well projected pf
T.D. 5802'
T.D. 6006'
NO HORIZONTAL SCALE
J. E. LOGAN & ASSOC. - Yearout #44
Sec. 26, T.14S., R.14E.
Elev. 452'
UNION - Nicholson 1-17
Sec. 17, T.15S., R.15E
Elev 196'
140,000'
T.D. 7062'
T.D. 9001'
Basal LODO - Paleocene transgression
Glau basal CERROS Sd
JERGINS - Chaney Ranch #1
Sec 29, T. 14S., R 13E.
Elev. 392'
RICHFIELD - Stone Bragg #1
Sec. 33, T. 13S., R.12E.
Elev. 355'
Basal Tk glauc. not cored
T. paschyceanis
T. paleocenis
T.D. 9204'
T.D. 5724'
Fossdale Top PANOCHE
Possible Top PANOCHE
SEABOARD - Oro Loma #1
Sec 12, T12S, R.11E.
Elev. 180'
3994' T. pachyceanis
3980 Acila (grinnelli)?
4123' pearly fragg
4312' pearly fragg
4330' Arca sp.
4580' - 4592' Lower T.L. (MORENO Bn Sh)
Sand and shale changes in facies
5617 Ammonite
5623' Baculites
T.D. 5802'
SEE SW - NE SECTION THROUGH THIS WELL AND OUTCROP TO WELL SECTION FOR CORR.
Top PANOCHE ?
S. clarki var. upper most 3 assoc w/ Ammonites in PANOCHE
AMERADA - Carano #1
Sec 19, T.10S., R 11E
Elev 117'
69000'
Expanded section of Paleocene sand - LAGUNA SECA
Paleocene transgression
Spot cored rec. bn sh and slt
Correlation depends upon ident of Siphs and assoc fauna
Siphs clarki var or clarki ? PANOCHE ( probably not S whitei of MORENO)
T.D. 8355
SEABOARD - Howard #1
Sec 6, T.8S., R.11E
Elev 85'
Goudkoffi Siphogenerinoides (what sp ?) clarki var or true clarki ??
Probably PANOCHE Siphs
T.D. 7074'
LITHOLOGIC COLUMNAR SECTIONS OF WELLS
VERTICAL SCALE
0 500' 1000' 1500' 2000' 2500'
HORIZONTAL SCALE
0 5000' 10,000' 20,000' 30,000' 40,000' 50,000'